Arithmetic

1913

CONTENTS.

NOTE. The easier part of the Section on Problems may be taken at a much earlier stage than is indicated by its position in the book; and Examples 36 and 37 may be omitted on the first reading.

ARITHMETIC.

CALCUTTA.

I. INTRODUCTION.

1. A **quantity** is anything, which may be regarded as being made up of parts like the whole. [*Hamblin Smith.*

Thus, a sum of money, the length of a rod, the weight of a sack of rice, a number of men, are quantities.

2. A quantity is called a **unit** quantity [or simply a *unit*] when it is used for the purpose of comparing [with its own] the magnitudes of other quantities of the same kind. [*J. B. Lock.*

Thus, a rupee is used as the unit of money when we speak of a certain sum as three *rupees*. A boy is the unit when we speak of a certain class in a school as containing fifteen *boys*.

3. That which indicates the magnitude of a quantity relatively to its unit is called a **number**.

Thus, the number *three* indicates the relative magnitude of the quantity *three rupees* as compared with its unit *a rupee.*

4. The **Measure** or **numerical value** of a quantity is the *number* which expresses how many times the unit is contained in the quantity.

Thus, if we use a yard as the unit of length, and speak of a certain length as five yards, the number five is the *measure* or *numerical value* of that length.

Note. The numerical value of a quantity indicates its *relative* magnitude. The *absolute* magnitude of a quantity is indicated by its numerical value and unit together.

5. A number is called an **abstract** number, when it is not attached to any particular unit ; as, *four*, *five*, *seven*.

6. A number is called a **concrete** number, when it is attached to some particular unit ; as, *four* horses, *five* men, *seven* yards.

7. **Arithmetic** is a part of the Science which teaches the use of numbers.

II. THE METHOD OF REPRESENTING NUMBERS BY FIGURES.

8. In Arithmetic we represent all numbers by means of the ten symbols or *figures*, 1, 2, 3, 4, 5, 6, 7, 8, 9, 0, called **digits.** The first nine of these figures are called the **significant** digits ; the last is called **zero, cipher or nought.**

9. Numbers from *one* to *nine* are represented by the nine significant digits taken in order. Thus

one	two	three	four	five	six	seven	eight	nine.
1	2	3	4	5	6	7	8	9

10. All higher numbers are represented by two or more of the figures, the following *convention* being adopted :

It is agreed that in a line of figures, the figure in the first place *towards the right* shall have its *simple value*,* and shall represent so many **units** ; the figure in the second place from the right shall have *ten times its simple value*, and shall represent so many *tens of units*, or **tens** ; the figure in the third place shall have *ten times the value it should have in the second place* or *one hundred times its simple value*, and shall represent so many *tens of tens*, or *hundreds, of units*, or **hundreds** ; thus 435 shall express one hundred times four units, together with ten times three units and also five units more ; or in other words, it shall express four hundreds, three tens and five units : and so on, the value of a figure increasing tenfold at each step of removal towards the left.

11. The following table, called the **Numeration Table**, gives the respective names of places of figures representing a number.

Hundreds of thousands of billions.	Tens of thousands of billions.	Thousands of billions.	Hundreds of billions.	Tens of billions.	Billions.	Hundreds of thousands of millions.	Tens of thousands of millions.	Thousands of millions.	Hundreds of millions	Tens of millions.	Millions.	Hundreds of thousands.	Tens of thousands.	Thousands.	Hundreds.	Tens.	Units.
9	8	7	6	5	4	3	2	1	9	8	7	6	5	4	3	2	1

* The value of a figure which it has when it stands by itself is called its *simple* or *intrinsic* value. The value of a figure which it has in consequence of its position in a line of figures is called its *local* or *accidental* value.

The periods which follow those in the above table are trillions, quadrillions, quintillions, sextillions, septillions, octillions, etc.

12. The symbol o has no value in itself and represents no number. In a line of figures, o in the first place (towards the right) indicates the absence of units; in the second place, absence of tens; in the third place, absence of hundreds; and so on.

Thus

30 represents three tens and *no units*;

400 represents four hundreds, *no tens*, also *no units*;

309 represents three hundreds, *no tens*, and nine units.

13. It appears then, that numbers from *one* to *nine* are represented by one figure; numbers from *ten* to *ninety-nine* are represented by two figures; numbers from *one hundred* to *nine hundred and ninety-nine* are represented by three figures; numbers from *one thousand* to *nine thousand, nine hundred and ninety-nine* are represented by four figures; and so on.

14. The method above explained of representing numbers by means of ten figures and their combinations was invented by the Hindus. But Europeans call it the Arabic Notation because it was introduced into Europe by the Arabs who had learnt it from the Hindus.

NUMERATION.

15. Numeration is the art of reading a number expressed in figures.

Art. 9 enables the learner to read the numbers expressed by one figure; and the following table will enable him to read the numbers expressed by two figures.

10 ten	23 twenty-three	36 thirty-six
11 eleven	24 twenty-four	37 thirty-seven
12 twelve	25 twenty-five	38 thirty-eight
13 thirteen	26 twenty-six	39 thirty-nine
14 fourteen	27 twenty-seven	40 forty
15 fifteen	28 twenty-eight	41 forty-one
16 sixteen	29 twenty-nine	42 forty-two
17 seventeen	30 thirty	43 forty-three
18 eighteen	31 thirty-one	44 forty-four
19 nineteen	32 thirty-two	45 forty-five
20 twenty	33 thirty-three	46 forty-six
21 twenty-one	34 thirty-four	47 forty-seven
22 twenty-two	35 thirty-five	48 forty-eight

49 forty-nine	66 sixty-six	83 eighty-three
50 fifty	67 sixty-seven	84 eighty-four
51 fifty-one	68 sixty-eight	85 eighty-five
52 fifty-two	69 sixty-nine	86 eighty-six
53 fifty-three	70 seventy	87 eighty-seven
54 fifty-four	71 seventy-one	88 eighty-eight
55 fifty-five	72 seventy-two	89 eighty-nine
56 fifty-six	73 seventy-three	90 ninety
57 fifty-seven	74 seventy-four	91 ninety-one
58 fifty-eight	75 seventy-five	92 ninety-two
59 fifty-nine	76 seventy-six	93 ninety-three
60 sixty	77 seventy-seven	94 ninety-four
61 sixty-one	78 seventy-eight	95 ninety-five
62 sixty-two	79 seventy-nine	96 ninety-six
63 sixty-three	80 eighty	97 ninety-seven
64 sixty-four	81 eighty-one	98 ninety-eight
65 sixty-five	82 eighty-two	99 ninety-nine

16. When a number is expressed by *three* figures, the third figure from the right is read as so many *hundred*, the two remaining figures being read together as in the above table. Thus

the number expressed by 100 is read *one hundred*;
the number expressed by 340 is read *three hundred and forty*;
the number expressed by 452 is read *four hundred and fifty two*;
the number expressed by 607 is read *six hundred and seven.*

17. If a number is expressed by more than three figures, divide the line of figures by commas into periods of three figures each, commencing from the right; and read the first period (towards the right) as in Art. 16, read the second period as so many *thousand*, the third period as *million*, the fourth as *thousand*, the fifth as *billion*, the sixth as *thousand*, and so on. *The periods must be read off from left to right in order.*

Thus

2,435 is read 'two *thousand*, four hundred and thirty-five';
23,204 is read 'twenty-three *thousand*, two hundred and four';
234,021 is read 'two hundred and thirty-four *thousand* and twenty-one';
324,103,200 is read 'three hundred and twenty-four *million*, one hundred and three *thousand*, two hundred';
36,204,340,432,004 is read 'thirty-six *billion*, two hundred and four *thousand*, three hundred and forty *million*, four hundred and thirty-two *thousand* and four.'
1,000 represents a thousand;
1,000,000 represents a million;
1,000,000,000,000 represents a billion.

EXAMPLES. 1.

To be done first orally, then in writing.

Express each of the following numbers in words :

1. 10; 16; 48; 99; 76; 43; 50; 31; 62.
2. 100; 111; 902; 620; 300; 103; 234; 130.
3. 9216; 5409; 5004; 1011; 1110; 9000; 9999.
4. 12345; 20103; 40040; 50001; 90600; 89346.
5. 500000; 708900; 102030; 209809; 379586.
6. 7234651; 7090709; 9000000; 7800040; 3567891.
7. 32567892; 34083092; 90009000; 55500055.
8. 789345621; 390085000; 222000000.
9. 7009056700; 3259287891; 8070088200.
10. 32500094001; 308506008230; 1357986428123.
11. What is the local value of each of the significant digits in the numbers, 72, 359, 4203, 70809, 1300450789 and 3079004078023?
12. What does each of the zeros in the numbers 20103, 307005060 and 300508230509 indicate?
13. Express in words the least number of five figures and the greatest number of four figures.

NOTATION.

18. **Notation** is the art of representing by figures a number expressed in words.

The method is as follows :

Begin at the left hand, and put down the required figures in the places necessary to express the number, according to the Numeration Table ; and fill up the vacant places, if any, with ciphers.

Thus, to represent by figures the number, *five million, twenty-eight thousand, three hundred and four*, we put down 5 in the place of *millions* or in the seventh place from the right, 2 in the place of *tens of thousands* or in the fifth place, 8 in the place of *thousands* or in the fourth place, 3 in the place of *hundreds* or in the third place, and 4 in the place of *units* or in the first place ; and then we fill up the sixth and second places with ciphers ; and the number expressed in figures is 5028304.

EXAMPLES. 2.

State in figures :

1. Thirteen ; seventeen ; nineteen ; twelve ; eleven.

2. Twenty-three ; thirty-four ; forty ; twenty-seven.

3. Seventy-seven ; ninety ; eighty-four ; sixty-three.

4. Three hundred and forty-two ; four hundred and eighty-six ; five hundred and four ; nine hundred.

5. Two hundred and three ; four hundred and thirty ; five hundred and fifty-five ; four hundred.

6. Eight hundred and ninety-two ; seven hundred and four ; six hundred and forty ; five hundred and twelve.

7. Seven thousand, eight hundred and thirty-five ; nine thousand and twenty-eight ; six thousand and nine ; four thousand ; six thousand and eighty-five.

8. Five thousand, nine hundred and ninety-two ; eight thousand and seventy-four ; two thousand and three ; four thousand and forty ; three thousand, four hundred and three.

9. Twelve hundred ; eighty thousand and eight ; eighteen thousand, four hundred and fifty-four ; thirty-six thousand and twelve ; ninety thousand.

10. Twenty thousand and seventy ; thirty thousand and eight ; fifty-four thousand, four hundred ; sixteen thousand and four.

11. Four hundred and five thousand ; eight hundred thousand and forty ; seven hundred and two thousand and seventy-four.

12. Three million, nine hundred and four ; nine million, four hundred ; fifteen million and fifty ; one hundred and eight million, three thousand and four ; four million and five thousand.

13. Five thousand million, seven hundred thousand and twenty-eight ; three hundred and fifteen thousand seven hundred and sixty-four million, nine thousand and three.

14. Three billion and fifty ; four hundred and five billion, ten million, twenty thousand and seven ; one billion, one million, one thousand ; six billion and six.

15. Five hundred and twelve billion, two hundred and fifty-five thousand seven hundred and sixty-two million, seven hundred and thirteen thousand, four hundred and seventy-three.

16. Twelve billion and twelve ; seven hundred billion, seven hundred thousand and seven hundred ; three billion, three million, three thousand, three hundred and three.

17. Seven thousand three hundred and five billion, five hundred and two million, six thousand and twenty-four ; forty-seven billion, forty-seven million, forty-seven thousand and forty-seven.

18. State in figures the least number of seven figures and the greatest number of five figures.

19. One boy wrote 70007007 and another wrote 777 when told to write 'seven thousand, seven hundred and seven' in figures; what mistakes did they commit?

THE INDIAN METHOD OF NUMERATION.

19. The following is the Indian Numeration Table in common use:

Hundreds of crores.	Tens of crores.	Crores.	Tens of lacs.	Lacs.	Tens of thousands.	Thousands.	Hundreds.	Tens.	Units.
1	9	8,	7	6,	5	4,	3	2	1

The above number is read thus:

One hundred and ninety-eight crores, seventy-six lacs, fifty-four thousand, three hundred and twenty-one.

Note. The Hindu names of places of figures are as follow:— *aka*, *dasha*, *shata*, *sahasra*, *ojut*, *lakkha* (lac), *nijut*, *coti* (crore), *arbud*, *padma*, *kharba*, *nikharba*, *mokapadma*, *sanku*, *jaladhi*, *antya*, *madhya*, *parardhya*.

EXAMPLES. 3.

Express in words according to the Indian Numeration:

1. 345543; 3020050; 7990570; 7050304.

2. 12345678; 305750080; 45000000.

3. 2300780001; 7080904080; 3794857612.

4. 8274057009; 3500001230; 3103705040.

5. 1234567890; 6000789000; 5010702009.

Express in figures:

6. One lac, fourteen thousand; seventy-eight lacs; fifteen lacs, four thousand and thirty; seven lacs and seven.

7. One crore, five hundred; twenty-eight crores, three lacs and four; twenty crores; one crore, one lac, one thousand and one.

8. Three hundred crores, five lacs, four thousand; one hundred and one crore, one lac, one hundred and one.

9. Three hundred and twenty-eight crores, seventeen lacs, forty-five thousand, seven hundred and fifteen.

10. Seven hundred and five crores, seventeen lacs, twenty-four thousand, seven hundred and thirty-eight.

11. How many thousands are in a lac ? How many lacs in a million ? How many millions in a crore ?

12. Read according to the Indian numeration the number—one hundred and three million, twenty-eight thousand, four hundred and one.

13. Read according to the English numeration the number—one hundred and three crores, seven lacs, seven hundred and four.

THE ROMAN SYSTEM OF NOTATION.

20. In this system the symbols chiefly employed are I, V, X, L, C, D and M which represent 1, 5, 10, 50, 100, 500 and 1000 respectively. Again a bar placed over a letter increases its value a thousand-fold ; thus $\overline{X}$ represents 10,000.

The following table will explain the method of representing any number by means of the above symbols.

I	1	XI	11	XXX	30	CD	400
II	2	XII	12	XL	40	D	500
III	3	XIII	13	L	50	DC	600
IV	4	XIV	14	LX	60	DCC	700
V	5	XIV	15	LXX	70	DCCC	800
VI	6	XVI	16	LXXX	80	CM	900
VII	7	XVII	17	XC	90	M	1000
VIII	8	XVIII	18	C	100	MCD	1400
IX	9	XIX	19	CC	200	MCM	1900
X	10	XX	20	CCC	300	MM	2000
MDCCCLXXXIX			1889	$\overline{\text{DLX}}$DCCXLII			560742

EXAMPLES. 4.

Express in Arabic notation :

1. VI. 2. IX. 3. XLIX. 4. XCIX.
5. LXXV. 6. CCLXIV. 7. DCIX. 8. DCLXIV.
9. MCMXC. 10. LXX. 11. MMDCCLXIV.

Express in Roman notation :

12. 44. 13. 66. 14. 79. 15. 83.
16. 149. 17. 436. 18. 990. 19. 1351.
20. 5670. 21. 3149. 22. 45978. 23. 1000000.

III. ADDITION.

21. **Addition** is the method of finding a single number which is equal to two or more given numbers taken together.

The given numbers are called **summands**, and the single number obtained by adding them is called their **sum** or **amount**.

22. The sign + signifies that the two numbers between which it is placed are to be *added.* Thus, $7+2$ signifies that 2 is to be added to 7. The sign + is called the **plus sign**, and $7+2$ is read "seven *plus* two."

The sign = stands for the words "is equal to" or "equals." Thus, $2+3=5$ states that the sum of 2 and 3 *is equal to* 5. The sign = is called the **sign of equality**, and $2+3=5$ is read "two plus three **is equal to** five" or "two plus three **equals** five."

23. The numbers *one, two, three, four, five*, etc. being taken in order, if we add the number *one* to any one of them, we get the number next following: thus $1+1=2$; $2+1=3$; $3+1=4$; and so on.

We obtain the sum of 5 and 3 thus:

$$\begin{aligned}5+3&=5+2+1\\&=5+1+1+1\\&=6+1+1\\&=7+1\end{aligned}$$

Results thus obtained are registered in the following table, called the Addition Table, which the learner should commit to memory.

1 and	2 and	3 and	4 and	5 and	6 and	7 and	8 and	9 and
1 are 2	1 are 3	1 are 4	1 are 5	1 are 6	1 are 7	1 are 8	1 are 9	1 are 10
2 ... 3	2 ... 4	2 ... 5	2 ... 6	2 ... 7	2 ... 8	2 ... 9	2 ...10	2 ...11
3 ... 4	3 ... 5	3 ... 6	3 ... 7	3 ... 8	3 ... 9	3 ...10	3 ...11	3 ...12
4 ... 5	4 ... 6	4 ... 7	4 ... 8	4 ... 9	4 ...10	4 ...11	4 ...12	4 ...13
5 ... 6	5 ... 7	5 ... 8	5 ... 9	5 ...10	5 ...11	5 ...12	5 ...13	5 ...14
6 ... 7	6 ... 8	6 ... 9	6 ...10	6 ...11	6 ...12	6 ...13	6 ...14	6 ...15
7 ... 8	7 ... 9	7 ...10	7 ...11	7 ...12	7 ...13	7 ...14	7 ...15	7 ...16
8 ... 9	8 ...10	8 ...11	8 ...12	8 ...13	8 ...14	8 ...15	8 ...16	8 ...17
9 ...10	9 ...11	9 ...12	9 ...13	9 ...14	9 ...15	9 ...16	9 ...17	9 ...18

Example. Add $7+8+9+8$.

Process: $7+8=15$; $15+9=24$; $24+8=32$ *Ans.*

Note. As facility in mental addition is the basis of all accurate facility in the subsequent processes of Arithmetic, the pupil should have a sufficient number of exercises in mental addition before he proceeds further. The use of fingers should be strictly prohibited.

EXERCISES IN MENTAL ADDITION.

N. B. The following exercises are not considered sufficient; they are intended only to show the nature of the questions that might be asked.

1. What is the sum of

(*a*) 2 and 9; 3 and 4; 8 and 7; 7 and 5; 9 and 9; 9 and 7; 3 and 7; 8 and 5; 9 and 6; 6 and 8; 8 and 9; 7 and 3?

(*b*) 10 and 7; 20 and 8; 30 and 6; 50 and 9; 70 and 5?

(*c*) 11 and 6; 12 and 7; 26 and 4; 36 and 3; 72 and 7?

*(*d*) 15 and 7; 16 and 8; 22 and 9; 37 and 6; 85 and 9; 43 and 8; 49 and 9; 28 and 7; 68 and 7; 98 and 7; 99 and 9?

2. Add

(*a*) 5 to 7, to 17, to 27, to 37, etc.

(*b*) 7 to 9, to 19, to 29, to 39, etc.

(*c*) 8 to 8, to 18, to 28, to 38, etc.

3. (*a*) How much do 1 and 2 make? 3 and 2? 5 and 2? etc.

(*b*) How much do 2 and 3 make? 5 and 3? 8 and 3? etc.

(*c*) How much do 3 and 5 make? 8 and 5? 13 and 5? etc.

N. B. When the pupil has acquired a little facility the above question may, with advantage, be put in the following form:

4. Count by increments of 6 starting at 4.

Answer. 4, 10, 16, 22, 28, 34, etc.

5. I have 10 marbles in one hand and 7 in the other; how many marbles have I in all?

6. Twelve articles make a dozen; how many in two dozen?

7. Ram had 19 marbles and he has won 8; how many marbles has he now?

8. I have purchased a table for 16 rupees and a chair for 7 rupees; how many rupees have I spent in all?

9. If mangoes are selling at the rate of 13 for the rupee, how many shall you get for two rupees?

10. John bought 25 mangoes and 9 oranges; how many fruits did he buy in all?

*The following process in mental addition may be recommended for beginners:—

$$15+7=15+5+2=20+2=22.$$

But the process should be abandoned as soon as facility in addition has been acquired.

11. You are 13 years old; your brother is 7 years older than you; what is the age of your brother?

12. If I give you 20 rupees I shall have 15 rupees left in my purse; how many rupees have I?

13. A boy has lost 8 marbles and has 27 left; how many had he at first?

14. You have 23 marbles in your pocket; I give you 9: how many have you now in all?

15. A man bought 35 maunds of rice on a certain day, and 9 maunds on the next day; how many maunds did he buy in all?

16. A man's age is 47 years; how old will he be 7 years hence?

17. If you buy 56 mangoes and your brother 8 more than you, how many does your brother buy?

18. What is the number from which if I take 15 there will remain 60?

19. A man bought a table for 75 rupees and gained 5 rupees by selling it; for how many rupees did he sell it?

20. A man gave 19 rupees to his wife, 7 rupees to his son and 4 rupees to his daughter; how many rupees did he give away in all?

21. What is the united length of five roads which are 1, 2, 3, 4 and 5 miles long respectively?

22. I bought a book for 6 annas and a bottle of ink for 4 annas more than the book; how much did I spend in all?

23. A man sold 9 oranges to *A*, to *B* 7 more than to *A*: how many did he sell in all?

24. Ram bought 2 mangoes at 4 annas each and 8 oranges at one anna each; how much did he pay to the fruit-seller?

25. From a rope are cut off first 27 yards, then 8 yards, and there are 7 yards left; what was the length of the rope?

24. In the case of large numbers the process of addition is as follows:

Example. Add together 378, 409 and 56.

We write down the numbers, one under another, thus

$$\begin{array}{r} 378 \\ 409 \\ 56 \\ \hline 843 \end{array}$$

placing units under units, tens under tens, hundreds under hundreds, and so on; and then draw a line under the lowest line of

figures. Under this line we place the sum which is found in the following way :

We first add the units, thus (8+9+6) units = 23 units = 2 tens + 3 units ; we place the 3 under the column of units and *carry on* the 2 tens for adding to the column of tens. Next we add the tens, thus (2+7+0+5) tens = 14 tens = 1 hundred + 4 tens ; we place the 4 under the column of tens and *carry on* the 1 hundred for adding to the column of hundreds. We then add the hundreds, thus (1+3+4) hundreds = 8 hundreds : and we place the 8 under the column of hundreds.

Mental Process :	8,	17,	23 ;
carry 2,		9,	14 ;
carry 1,		4,	8.

EXAMPLES. 5.

N. B. Sums should be dictated and the pupils required to read out the answers in words. The same sum may be given several times by altering the order of the summands.

Add together

1.	2.	3.	4.	5.
3	6	8	7	8
5	9	7	5	9
9	8	9	8	8
4	7	7	9	9

6.	7.	8.	9.	10.
56	73	40	90	79
42	26	37	50	84

11.	12.	13.	14.	15.
375	879	79	986	984
208	82	40	742	76
740	190	673	999	940

16.	17.	18.	19.
7643	429	3098	4807
248	7	207	309
5004	84	40	4
1234	9476	329	500

20.	21.	22.	23.
28	58073	839	38756
4007	9705	2058	50952
350	368	476	78095
9	78000	8105	34566
302	29	47460	32308

24.	25.	26.	27.
89763	38760	467895	79
25964	5807	58009	3025
73890	304	5555	329
58926	19	795073	876502
32167	7	567082	39879
[illegible]	374	368000	309

28.	29.	30.	31.
9038	7	3578924	9357350
30054	7000007	5893679	[illegible]84721
5028	34003	8279563	8[illegible]5902
76	404040	9528789	7650729
9	36000	3474923	8472038
938050	38	8923463	5679824

Find [illegible] sum of

32 [illegible]4, 97056, 48, 397834 and 909

33 73568, 9340, 8654, 76, 703 and 98.

34 74, 79048, 309, 800038, 43 and 3002.

35 300, 785, 897634, 12345, 207 and 20708

Find the value of

36 432398 + 7[illegible] + 83989 + 7050

37 7[illegible] + 8200 + 7396 + 5678920 + 97 + 2

38. 3 + 309 + 29 + 30[illegible]805 + 3253 + 500

39 87 + 9800000 + 80234 + 10201 + 34567 + 9

40. 3456 + 456 + 56 + 6 + 76000 + 98453[illegible]89

41. Add together the following numbers seventy-nine; three thousand, four hundred and fifty, sixty six thousand, six hundred and ninety four; four thousand and four, eighty

42. Find the total of—six hundred and ninety-two; four lacs, forty-five thousand and seven, ninety eight lacs, seven hundred; forty-five; seven

43. Find the amount of—seven hundred and forty-six million, seventy-four thousand, nine hundred and sixty-two; eighty-six thousand, five hundred and four, twelve million, seven thousand and three; ninety-one, seven million and seven.

44. How much are nineteen + seven lacs, seven thousand and seven + three hundred and four crores, seventy four lacs and twenty-nine + eight crores, eight lacs, eight thousand and eight + seven thousand, seven hundred and forty-two + six + three lacs, four hundred and seven?

45. Find the amount of 76, 3[illegible], [illegible]0507, 8, 93[illegible], 900009, 370[illegible], [illegible]9, 3780589[illegible], 38, 7923000 and [illegible]2.

[illegible] What is the number from which [illegible] taken 479 is left?

47. [illegible]man was born in 1856; in [illegible] be 54 years of [illegible]?

48. J[illegible]ary has 31 days, February [illegible] March [illegible], April 30, May 31, [illegible] 30, July 31, August 31, September 30, October 31, November [illegible] and Decem[illegible]; how many days ar[illegible]ere in the whole year.

49. State how many boys are in a school in which there are 125 in the first class, 87 in the second, 96 in the third, 107 in the fourth, 70 in the fifth and 256 in the other classes.

50. A garden contains 327 mango trees, 704 cocoanut trees, 456 date trees, 528 orange trees and only 25 tamarind trees: how many trees are there in all?

51. A certain town contains 87,903 Hindus, 48,093 Mahomedans, 723 Europeans, 1,309 Eurasians and 159 other races: what is the total population of the town?

52. A gentleman bought three pieces of land in a town for 9,700 rupees; he built a house on one piece at a cost of 7,825 rupees, another on the second piece at a cost of 21,750 rupees, and a third on the remaining piece at a cost of 2,729 rupees: what sum did he spend in all?

53. We imported 53,89,082 maunds of salt in January 1885; 7,09,280 maunds in February and 10,94,803 maunds in March: what was the entire weight imported in the first 3 months of 1885?

54. I bought four baskets of mangoes; the first contained 246 mangoes; the second 319; the third 19 more than the second; and the fourth as many as the first and second together: how many mangoes did I buy?

55. What is the number from which if I first take 70835 and then 85679, there will remain 7040?

IV. SUBTRACTION.

25. **Subtraction** is the method of finding the number which is left when the *smaller* of two given numbers is taken from the *greater*.

The greater of the two given numbers is called the **minuend**, the less is called the **subtrahend**, and the number found by subtraction is called the **remainder** or **difference**.

The sign $-$, placed between two numbers, signifies that the second number is to be *subtracted* from the first. Thus $7-4$ signifies that 4 is to be subtracted from 7. The sign $-$ is called the **minus sign**, and $7-4$ is read "seven *minus* four."

26. It follows from the definition of subtraction that it is the process of finding the number which must be *added* to a given number to make a larger given number. Hence subtraction is sometimes called *complementary addition*.

We are able to subtract a small number from another, from the known results of the Addition Table.

Example. $7-4=3$, because $4+3=7$.

EXERCISES IN MENTAL SUBTRACTION.

1. Take 3 from 8; 4 from 9; 5 from 7; 6 from 9; 5 from 8.

2. What is the difference between 10 and 6; 12 and 8; 6 and 9; 13 and 7; 11 and 6; 16 and 8; 18 and 9; 15 and 7; 17 and 8?

3. How many does 7 leave from 28; 5 from 27; 6 from 56; 7 from 99; 3 from 57; 8 from 88; 6 from 49; 4 from 26?

4. Subtract 9 from 22; 8 from 35; 7 from 42; 6 from 51; 5 from 60; 4 from 73; 8 from 86; 9 from 92; 5 from 81.

5. (*a*) What remains when we take 6 from 30, 6 from 24, 6 from 18, 6 from 12, 6 from 6?

(*b*) What remains when we take 7 from 100, 7 from 93, 7 from 86, etc.?

(*c*) Count by decrements of 6 commencing at 100.
Ans. 100, 94, 88, etc.

6. Take 7 from the sum of 5 and 6; 9 from the sum of 6 and 8; 6 from the sum of 5 and 4; 8 from the sum of 6 and 7.

7. A boy who had 15 marbles has lost 8: how many has he left?

8. I have 17 rupees in my purse; if I give you 9 rupees, how many rupees shall I have left?

9. Your brother's age is 14 years; you are 5 years younger than he: how old are you?

10. In a class there are 19 boys on the roll; on a certain day 6 boys were absent: how many were present?

11. A man had 16 rupees; he gave 7 rupees to his wife and the rest to his son: how much did the son get?

12. A man bought a table for 19 rupees and sold it for 25 rupees: how much did he gain?

13. There are 37 mangoes on a tree; if 8 be plucked, how many will be left?

14. Ram has 48 marbles; if Gopal had 9 more than what he now has, he would have as many as Ram: how many has Gopal?

15. I have 16 marbles; John has 28; how many more should I get to have as many as John?

27. In the case of large numbers the process of subtraction is as follows:

Example 1. Subtract 34 from 86.

We place the smaller number under the greater, as in Addition. We now take 4 units from 6 units, and set down the result, which is 2 units, under the column of units;

$$\begin{array}{r} 86 \\ \underline{34} \\ 52 \end{array}$$

next, we take 3 tens from 8 tens, and set down the result, 5 tens, under the column of tens. Thus the remainder obtained is 52.

Example 2. Subtract 368 from 952.

$$\begin{array}{r} 952 \\ \underline{368} \\ 584 \end{array}$$

Here, proceeding as in the previous example, we meet with the difficulty of taking a greater digit from a less, and to get over this difficulty we avail ourselves of the following principle, usually termed *borrowing: The minuend and subtrahend may be increased by the same number without altering their difference*; and we reason thus :

We cannot take 8 units from 2 units ; we therefore add 10 units to the 2 units, making 12 units, and we take 8 units from the 12 units, and set down the result, 4 units, under the column of units. Having increased the upper number by 10 units, we add, by way of compensation, 1 ten to the lower number, changing 6 tens into 7 tens. We have now to take 7 tens from 5 tens, and as we cannot do so, we add 10 tens to the 5 tens, making 15 tens, and we take 7 tens from the 15 tens, and set down the result, 8 tens, under the column of tens. Having increased the upper number by 10 tens, we add, by way of compensation, 1 hundred to the lower number, changing 3 hundreds into 4 hundreds. We now take 4 hundreds from 9 hundreds, and set down the result, 5 hundreds, under the column of hundreds.

Note. Instead of the above process it will be practically convenient to determine how much must be added to the subtrahend to make up the minuend.

Example. Subtract 576 from 829.

We are to find the number which being added to 576 makes up 829.

$$\begin{array}{r} 829 \\ \underline{576} \\ 253 \end{array}$$

We place the smaller number under the greater, as in Addition. We now see that 6 units + 3 units = 9 units ; we therefore set down the 3 under the column of units : next, 7 tens + 5 tens = 12 tens ; we set down the 5 under the column of tens, and **carry** 1 hundred : then, (1 + 5) hundreds + 2 hundreds = 8 hundreds ; we set down the 2 under the column of hundreds.

Mental Process : 6 and 3 are 9 ;
7 and 5 are 12 ;
carry 1, 6 and 2 are 8.

EXAMPLES 6.

Perform the following subtractions :

1. $\begin{array}{r} 78 \\ \underline{35} \end{array}$	2. $\begin{array}{r} 95 \\ \underline{43} \end{array}$	3. $\begin{array}{r} 356 \\ \underline{134} \end{array}$	4. $\begin{array}{r} 789 \\ \underline{246} \end{array}$	5. $\begin{array}{r} 7825 \\ \underline{3504} \end{array}$

6. 64 39	7. 97 48	8. 86 78	9. 94 85	10. 93 60
11. 795 606	12. 480 399	13. 977 799	14. 843 384	15. 904 589
16. 5380 739	17. 54090 7073	18. 84321 53780	19. 85858 58585	20. 54321 12345
21. 20004 17325	22. 789356 99999	23. 708093 20503	24. 805400 70053	25. 7000203 500956

26. 82439 − 76893. 27. 93406 − 7990.

28. 90256 − 82789. 29. 80000 − 76138.

30. 1000000 − 999999. 31. 777770 − 88889.

32. 780004 − 389210. 33. 100956 − 39897.

34. What number must be added to each of the following numbers to make the sum equal to a million?—19, 305, 9475, 99446 and 43500.

35. What number must be taken from 93867 to leave 903?

36. By how much does a lac exceed twenty-nine?

37. By how much is a crore greater than one thousand and one?

38. By how much is seventy-nine less than ten thousand?

39. The Duke of Wellington was born in 1769 and died in 1852; how old was he at his death?

40. Sir Isaac Newton died in 1727 aged 85 years: when was he born?

41. Mount Everest is 29,100 feet high; Kinchinjunga is 28,177 feet high: by how many feet is the former higher than the latter?

42. If the receipts of a railway company are 3,98,450 rupees and the expenses 2,80,769 rupees, what are the profits?

43. A merchant bought goods for 3,000 rupees and sold them for 3,325 rupees: how much did he gain?

44. If I had 540 rupees more than I have, I should be able to clear a debt of 10,000 rupees: how much have I?

45. The sum of two numbers is 93875, and the greater number is 77359: what is the smaller number?

46. The smaller of two numbers is 3799, and their sum is 780900; what is the greater number?

47. What number must be subtracted from 7389 that the remainder may be 999?

48. Find the difference between the sum and difference of a million and a thousand.

49. *A* has 39,876 rupees; *B* has 3,758 rupees less than *A*; and *C* has 876 rupees less than *B*; how much has *C*?

50. A boy when told to write 'three thousand, four hundred and five' in figures wrote 30004005; how much more did he write?

51. A boy wrote 500403 when he was told to write 'fifty lacs, four thousand and three' in figures; how much less did he write?

28. The number to which the sign + is prefixed is called a **positive** number; and the number to which the sign − is prefixed is called a **negative** number. If no sign is prefixed to a number it is to be considered as *positive*. Numbers connected by the sign + or − are called **terms.**

The most convenient method of finding the value of an *expression* (in which several numbers are connected by the sign + or −) is to find the sums of the *positive* and *negative* numbers separately and then to take their difference.

Example. Find the value of $273-369+821-403$.

Now, $273+821=1094$; and $369+403=772$;

$\therefore$ the result required $=1094-772=322$.

EXAMPLES. 7.

Find the value of each of the following expressions:

1. $973-724+209$.

2. $78965-8795-7386$.

3. $8703-7935+3002-1030$.

4. $1600-924-300-88$.

5. $94567+3285-77777-304+64$.

6. To $753-98+7$ I first add 329, and then take the difference of 720 and 699 from the sum; what is the result?

7. By how much is the difference of 7203 and 4980 less than their sum?

8. By how much does the sum of $7985-899$ and 7003 exceed their difference?

9. The greater of two numbers is 94047, and their difference is $909+350$; what is the other?

10 What number must be added to $329+408-540$ that the sum may be one lac?

V. MULTIPLICATION.

29. Multiplication is a short method of finding the sum of a certain number of repetitions of a given number.

The number to be repeated is said to be *multiplied* by the number which indicates *how often* it is to be repeated. Thus, when 4 is multiplied by 3, the result is 4+4+4 or 12.

The number which is multiplied is called the **multiplicand**; the number by which it is multiplied is called the **multiplier**; and the resulting number is called the **product.**

The sign of multiplication is ×. Thus 7×4 signifies that 7 is to be multiplied by 4, and is read "seven *into* four" or "four times seven." Sometimes a dot (.) is used instead of ×.

30. The multiplier and the multiplicand may be interchanged without altering the value of the product. Thus 3×4=4×3; for, 3×4=3+3+3+3=12, and 4×3=4+4+4=12.

The multiplier and multiplicand are called **factors** of the product.

31. The following Multiplication Tables must be committed to memory by the pupil.

First Table.

	1	2	3	4	5	6	7	8	9	10
Once	1	2	3	4	5	6	7	8	9	10
Twice	2	4	6	8	10	12	14	16	18	20
3 times	3	6	9	12	15	18	21	24	27	30
4 times	4	8	12	16	20	24	28	32	36	40
5 times	5	10	15	20	25	30	35	40	45	50
6 times	6	12	18	24	30	36	42	48	54	60
7 times	7	14	21	28	35	42	49	56	63	70
8 times	8	16	24	32	40	48	56	64	72	80
9 times	9	18	27	36	45	54	63	72	81	90
10 times	10	20	30	40	50	60	70	80	90	100

Second Table.

	1	2	3	4	5	6	7	8	9	10
11 times	11	22	33	44	55	66	77	88	99	110
12 times	12	24	36	48	60	72	84	96	108	120
13 times	13	26	39	52	65	78	91	104	117	130
14 times	14	28	42	56	70	84	98	112	126	140
15 times	15	30	45	60	75	90	105	120	135	150
16 times	16	32	48	64	80	96	112	128	144	160
17 times	17	34	51	68	85	102	119	136	153	170
18 times	18	36	54	72	90	108	126	144	162	180
19 times	19	38	57	76	95	114	133	152	171	190
20 times	20	40	60	80	100	120	140	160	180	200

Third Table.

	11	12	13	14	15	16	17	18	19	20
11 times	121	132	143	154	165	176	187	198	209	220
12 times		144	156	168	180	192	204	216	228	240
13 times			169	182	195	208	221	234	247	260
14 times				196	210	224	238	252	266	280
15 times					225	240	255	270	285	300
16 times						256	272	288	304	320
17 times							289	[illegible]	323	340
18 times								324	342	360
19 times									361	380
20 times										400

EXERCISES ON THE MULTIPLICATION TABLE.

(Oral).

1. How much is 7 times 6 ? 8 times 9 ? 12 times 12 ? etc.

2. Multiply 12 by 8 ; 9 by 7 ; 16 by 9 ; etc.

3. What is the product of 9 and 9 ? of 16 and 6 ? etc.

4. What is the sum of 6 repeated 9 times ? 15 repeated 8 times ? etc.

5. What number is as great as 10 times 11 ? 7 times 9 ? etc.

6. If [illegible] boys have 6 marbles each, how many have they all together ?

7. How many rupees are there in 12 boxes, each containing 11 rupees ?

8. Sixteen annas make a rupee ; how many annas are there in 5 rupees ?

9. Fifteen boys sit on each form in a school, and there are fifteen forms ; how many boys are there ?

10. The multiplicand is 11 and the multiplier is 13 ; what is the product ?

11. The factors of a product are 9 and 19 ; what is the product ?

12. When mangoes are 20 for a rupee, how many can you buy for 5 rupees ?

13. There are 7 days in a week ; how many days are there in 8 weeks ?

14. In a house of 4 stories there are 15 rooms on each story ; how many rooms are there in the house ?

15. If a cow be worth 15 rupees, how much will you have to pay for 9 cows ?

16. On a page of a book there are 17 lines, and each line contains 19 letters ; how many letters are there in the page ?

17. By how much is 7 times 11 less than 90 ?

18. By how much is 3 times 16 greater than 35 ?

19. What number exceeds 9 times 9 by 19 ?

20. How many legs have 7 horses and 3 cows got altogether ?

32. We now proceed to show how large numbers are multiplied.

Example. Multiply 2095 by 3.

We arrange the numbers thus :

$$\begin{array}{r} 2095 \\ \underline{3} \\ 6285 \end{array} \text{ product.}$$

The product is found in the following way :

3 times 5 units is 15 units ; we set down 5 in the place of units, and *carry on* 1 for adding to tens : next, 3 times 9 tens is 27 tens, and adding 1 *carried*, the result is 28 tens ; we set down 8 in the place of tens, and *carry on* 2 for adding to hundreds : next, 3 times 0 is 0,* and adding 2 *carried*, the result is 2 hundreds ; we set down 2 in the place of hundreds : then, 3 times 2 thousands is 6 thousands ; and we set down 6 in the place of thousands. Thus the product is 6285.

Mental Process : 3 times 5, 15 ;
carry 1, 3 times 9, 28 :
carry 2, 2 ;
3 times 2, 6.

N. B. The student will see that the above short process is substantially the same as the following extended process of addition.

$$\begin{array}{r} 2095 \\ 2095 \\ \underline{2095} \\ 6285 \end{array}$$

EXAMPLES. 8.

Multiply

1. 23 by 2.	2. 32 by 3.	3. 21 by 4.
4. 39 by 5.	5. 47 by 6.	6. 58 by 9.
7. 98 by 8.	8. 76 by 9.	9. 85 by 9.
10. 329 by 3.	11. 405 by 7.	12. 879 by 9.
13. 3245 by 6.	14. 7089 by 5.	15. 9206 by 8.
16. 78956 by 4.	17. 89035 by 7.	18. 85503 by 9.

19. 34079 by 2, 3, 4, 5, 6, 7, 8, 9.

20. Find the value of 725+725+725+725+725.

33. If we write a cipher to the right of a number its value is increased tenfold ; hence, when we multiply a number by 10, the product is obtained by annexing 0 to the number. Thus $23 \times 10 = 230$. Similarly, when we multiply a number by 100, 1000,...the product is obtained by annexing 00, 000,...to the number.

Also, if we have to multiply a number by 30, we may first multiply it by 3, and then annex 0 to the result : the final result will be the product required. So also, if we have to multiply by 300, we may first multiply by 3 and then annex 00 to the result.

* $0 \times 3 = 0$; for $0+0+0=0$.

Example. Multiply 329 by 600.

Process :

$$\begin{array}{r} 329 \\ 600 \\ \hline 197400 \end{array} \quad \textit{Ans.}$$

EXAMPLES. 9.

[illegible]roduct of

1. [illegible]
2. 7035 by 40.
3. 3905 by 50.
4. [illegible]9.
5. 39 by 900.
6. 8229 by 700.
7. [illegible] 8000.
8. 9004 by 9000.
9. 30503 by 6000.
10. 7295 by 90, 800, 7000, 60000, 500000.

34. It is clear from the definition of multiplication that, if we have to multiply a number by 5, we may multiply it separately by 2 and 3, and then add the two results ; the final result will be the product required : if we have to multiply a number by 23 we may multiply it separately by 3 and 20, and then add the two results.

Example 1. Multiply 728 by 329.

(A)

$$\begin{array}{rl} 728 & \\ 329 & \\ \hline 6552 & = \text{product by } 9. \\ 14560 & = \quad ,, \quad ,, \quad 20. \\ 218400 & = \quad ,, \quad ,, \quad 300. \\ \hline 239512 & = \text{product by } 329. \end{array}$$

(B)

$$\begin{array}{r} 728 \\ 329 \\ \hline 6552 \\ 1456 \\ 2184 \\ \hline 239512 \end{array}$$

Here, to obtain the product of 728 by 329, we multiply 728 by 9, 20 and 300 separately, and add the three results. The partial products are found by the methods explained in the two preceding articles.

In practice we do not annex the zeros in multiplying by 20 and 300 (because they have no effect in the addition which we perform afterwards) and our work stands as at (B).

OBSERVE that the multiplier must be placed under the multiplicand as in Addition ; also that, *in all cases*, the first figure on the right of each partial product must be placed in the same vertical column with the figure by which the product is obtained.

Note 1. We may multiply by the figures of the multiplier in any order we like, bearing in mind the foregoing observation.

(1)

$$\begin{array}{rl} 728 & \\ 329 & \\ \hline 1456 & \text{by } 2. \\ 2184 & \text{by } 3. \\ 6552 & \text{by } 9. \\ \hline 239512 & \end{array}$$

(2)

$$\begin{array}{rl} 728 & \\ 329 & \\ \hline 2184 & \text{by } 3. \\ 1456 & \text{by } 2. \\ 6552 & \text{by } 9. \\ \hline 239512 & \end{array}$$

Note 2. When the multiplier or multiplicand or [illegible]end with ciphers, it is convenient first to omit them in working and then to annex as many ciphers to the product as have been omitted.

Example 2 Multiply 37008 by 4203; 4309 by 12300; 290 by 243; and 40300 by 4370.

(1)	(2)	(3)	
37008	4309	290	
4203	12300	243	
111024	12927	87	
74016	8618	116	
148032	4309	58	
155544624	53000700	70470	176111000

EXAMPLES 10

Perform the following multiplications

1. 375 × 54
2. 904 × 98
3. 740 × 69.
4. 4972 × 345
5. 8762 × 904
6. 8072 × 972
7. 708 × 708
8. 8463 × 340.
9. 8259 × 5009
10. 89025 × 8007
11. 90407 × 6050
12. 123456 × 70809.
13. 863400 × 70600.
14. [illegible]78 × 90072.
15. 480390 × 8907.
16. 8573056 × 900082
17. 7390250 × 3009000.
18. 9876507 × 39421.
19. 3700 × 809025000.
20. 9876543 × 978653
21. 370304 × 6070370
22. 307650 × 900600.
23. 784692 × 800[illegible].
24. 830038 × 700208
25. 3257650 × 3257650.
26. 35756 × 6570002.
27. 209030 × 400800600.

Obtain the following products by using one line of multiplication only:

28. 4329 × 11
29. 3809 × 12.
30. 7204 × 13.
31. 7082 × 14.
32. 4890 × 15.
33. 8789 × 16.
34. 13579 × 17.
35. 28070 × 18.
36. 4316 × 19.

37. There are 192 pies in a rupee; how many pies are there in 3705 rupees?

38. A book contains 579 pages, and each page contains 3740 letters; how many letters are there in the whole book?

39. If the price of one cottah of land in Calcutta be 975 rupees, what is the price of [illegible]25 cottahs?

40. If [illegible]00 persons cross the Hughly Bridge daily, how many cross in a year of 365 days?

[illegible] What is the weight of 739 bags of rice, each wei[illegible]g 28 maunds ?

42. How many rupees must be paid for 6 elephants at 3479 rupees each, and 16 horses at 765 rupees each ?

43. [illegible]istern has a leak by which 78 tolas of water come out per [illegible] full cistern is emptied in $4\frac{3}{8}$ hours, how many tolas [illegible] cistern hold ?

Find the continued product [illegible]

[illegible] 28 by 8, and the product by 3, the final [illegible] being 672.

$$\begin{array}{r} 28 \\ 8 \\ \hline 224 \\ 3 \\ \hline 672 \end{array}$$ *Ans.*

EXAMPLES. II.

Find the following continued products :

1. $27 \times 8 \times 2$. 2. $703 \times 85 \times 79$. 3. $8050 \times 70 \times 30$.
4. $59 \times 85 \times 76 \times 5$ 5. $3205 \times 9 \times 8 \times 5$ 6. $99 \times 88 \times 77 \times 66$.

7. How much is twice nine times seventy-three ?

8. A day contains 24 hours, an hour contains 60 minutes, and a minute contains 60 seconds ; how many seconds are there in a day ?

9. 5 tolas make a chatak ; 16 chataks make a seer ; 40 seers make a maund : how many tolas are there in a maund ?

10. A book contains 379 pages, each page contains 27 lines, and each line contains 45 letters ; how many letters are there in the whole book ?

11. How many mangoes are there on a tree which has 29 branches, each branch containing 325 mangoes ?

12. In a railway-train there are 46 carriages ; each carriage has 6 compartments ; and each compartment contains 8 persons ; how many persons are there in the train ?

24. The *second, third, fourth,...* **power** of a number is the product of *two, three, four,...* factors each equal to that number. Thus the second power of $2 = 2 \times 2 = 4$; the third power of $2 = 2 \times 2 \times 2 = 8$. The second power of a number is called its **square**, the third power its **cube**. The number itself is often called its *first* power.

The symbol 4^2 is used to express 4×4 ; also 4^3 is used to express $4 \times 4 \times 4$; and so on. The small figures 2, 3, are called **indices** or **exponents** of the powers.

The process of finding any power of a number is called **Involution**.

EXAMPLES. 12.

Find the square of

1. 1, 2, 3, 4, 5,...19, 20.	2. 24.	3. 50.
4. 68.	5. 100.	6. 112.
7. 248.	8. 729.	

Find the cube of

10. 1, 2, 3, 4,...19, 20.	11. 93.
13. 879.	14. 555.

16. Find the value of $25^2+40^3-12^3+2^4$.

VI. DIVISION.

37. Division is the operation by which we find **how often** one given number, called the **Divisor**, must be subtracted from another given number, called the **Dividend**, so that the **Remainder**, if any, may be less than the first given number.

The *number* of times the subtraction is performed is called the **Quotient**.

It will be found that 7 units can be subtracted from 30 units, 4 times, and that then 2 units out of 30 remain over. Hence, when 30 is divided by 7, 30 is the *dividend*, 7 is the *divisor*, the *quotient* is 4 and the *remainder* is 2.

The sign of division is $\div$. Thus $30\div7$ signifies that 30 is to be divided by 7, and is read "30 *divided by* 7" or simply "30 *by* 7." The symbol $\frac{30}{7}$ is also used to denote the same operation of division.

38. It follows from the definition of division that

Divisor $\times$ Quotient $+$ Remainder $=$ Dividend.

When there is no remainder the division is said to be **exact**. In this case division may be explained as the *inverse* of multiplication, the quotient being the number whose product by the divisor is the dividend.

39. By division we break up a number (dividend) into equal parts: if the divisor represents the magnitude of a part, the quotient gives the number of the parts; if the divisor represents the number of the parts, the quotient gives the magnitude of one of the parts.

Example 1. 30 oranges are divided among boys so that each boy gets 7 oranges; how many boys get a share? (*Ans.* 4 boys, 2 oranges remainder).

[illegible]*ple* 2. 30 oranges are divided equally among 7 boys; how [illegible]y does each boy get? (*Ans.* 4 oranges each, 2 oranges remainder).

N. B. The teacher should explain how in both of these cases the result may be obtained by repeated subtractions.

[illegible]ivision of numbers not greater than 400 by numbers [illegible]20 is effected by means of the Multiplication Table.

[illegible]vide 59 by 7.

[illegible]e to find how often 7 may be subtracted from 59, or [illegible]ds, *how many times 7 is contained* in 59.

We may find the quotient and the remainder by successive subtractions of 7 from 59. But we are saved the trouble of repeated subtractions by using a known result of the Multiplication Table. Thus, since 8 times 7 is 56, 59÷7 gives 8 as quotient and 3 as remainder.

EXERCISES IN MENTAL DIVISION.

1. How many times is 5 contained in 20? 8 in 72? 9 in 54? 14 in 14? 16 in 128? etc.

2. How many times can you subtract 7 from 56? 6 from 48? 9 from 81? 18 from 306? etc.

3. Divide 84 into 7 equal parts; 104 into 13 equal parts; etc.

4. What is the fourth part of 36? sixth part of 54? twelfth part of 108? etc.

5. In 54 how many times 4, and how many over? how many times 5, and how many over? etc.

6. What is the remainder when 7 is subtracted as often as possible from 64? 6 from 42? 8 from 84? etc.

7. Find the quotient and remainder when 43 is divided by 6; 70 by 8; 85 by 9; 190 by 16; etc.

8. How many times does the fourth part of 72 contain 3? fifth part of 70 contain 7? etc.

9. 135 mangoes were divided equally among 15 boys; how many did each get?

10. 54 oranges are distributed equally among the children of a family, and each one gets 9; how many children are there in the family?

11. There are 16 annas in a rupee; how many rupees are there in 144 annas?

12. I bought a dozen chairs for 72 rupees; what is the price of a single chair?

13. How many yards of cloth at 12 annas each can [illegible] for 180 annas ?

14. How many dogs have 80 legs ?

41. When the dividend and divisor are any numbers, the process of division is as follows :

Example. Divide 88909 by 24.

The form of the operation is

```
24 ) 88909 (3704 Quotient.
     72
     169
     168
       109
        96
        13 Remainder.
```

The explanation is this :

We first take 8, and we find that 24 is not contained in it : we therefore take 88 and find how often 24 is contained in 88, and as it is contained three times, we set down **3** as the first figure in the quotient ; then multiply 24 by 3 and subtract the result 72 from 88 : to the remainder 16 we bring down the next figure in the dividend ; then, as 24 is contained in 169 seven times, we set down **7** as the second figure in the quotient ; then multiply 24 by 7 and subtract the result 168 from 169 : to the remainder 1 we bring down the next figure in the dividend ; then, as 24 is not contained in 10 we set down **0** as the third figure in the quotient and bring down 9, the next figure in the dividend ; then, as 24 is contained in 109 four times, we set down **4** as the fourth figure in the quotient ; then multiply 24 by 4 and subtract the result 96 from 109. We thus obtain 3704 as quotient and 13 as remainder.

N. B. The student will see that in the above process what we really do is this : from the dividend we first subtract 3000 times 24, next from the remainder we subtract 700 times 24, and then from the second remainder we subtract 4 times 24 ; we therefore altogether subtract (3000 + 700 + 4) or 3704 times 24 from 88909. The form of this extended operation is shown at the side.

```
24 ) 88909 ( 3000
     72000
     16909 (  700
     16800
       109 (    4
        96
Remr.   13   3704 Qt.
```

EXAMPLES. 13.

Divide

1. 376 by 2.	**2.** 9234 by 2.	**3.** 7085 by 2.
4. 7000 by 3.	**5.** 8025 by 3.	**6.** 90126 by 3.

7.	82045 by 4.	**8.**	32813 by 4.	**9.**	45678 by 4.
10.	12345 by 5.	**11.**	100200 by 5.	**12.**	77777 by 5.
13.	90403 by 6.	**14.**	87345 by 6.	**15.**	78934 by 6.
16.	3789 by 7.	**17.**	45986 by 7.	**18.**	32480 by 7.
19.	38474 by 8.	**20**	34509 by 8.	**21.**	16042 by 8.
[illegible]	721[illegible] 9.	**23.**	90001 by 9.	**24.**	78000 by 9.
[illegible]	3897[illegible].	**26.**	24560 by 10.	**27.**	32000 by 10.
[illegible]	7777[illegible].	**29.**	39042 by 16.	**30.**	57084 by 19.
[illegible]	38[illegible] 26.	**32.**	72043 by 37.	**33.**	96100 by 48.
34.	10000 by 59.	**35.**	707070 by 62.	**36.**	10020 by 74.
37.	35896 by 88.	**38.**	47500 by 91.	**39.**	28923 by 329.
40.	97856 by 141.	**41.**	13013 by 269.	**42.**	26534 by 584.
43.	89089 by 555.	**44.**	36780 by 628.	**45.**	30321 by 681.
46.	398406 by 879.	**47.**	700000 by 991.	**48.**	999999 by 8888.
49.	809345 by 3456.	**50.**	3270457 by 1002.	**51.**	7766334 by 7634.

52.	2080400 by 5456.	**53.**	9997770 by 3906.
54.	47946387 by 7207.	**55.**	987654321 by 8642.
56.	123456789 by 98765.	**57.**	187654321 by 12345.
58.	108c924890 by 72034.	**59.**	1200730092 by 897324.
60.	38407890901 by 90735.	**61.**	208900563000 by 870056.
62.	297506823 by 708076.	**63.**	567892314670 by 8976867.
64.	780184920271 3 by 926.	**65.**	98765404567S9 by 999.

66. The product of two numbers is 357435; one of them is 705; what is the other?

67. How many men will receive 113 rupees each out of 4068 rupees?

68. How often must 817 be taken to make up 431376?

69. What number multiplied by 493 will produce 6409?

70. I subtract 3405 from 780953, then subtract 3405 from the remainder, and so on: how often can I do this?

71. The quotient is 307, the divisor 98 and the remainder 29; what is the dividend?

72. The population of a certain town is 345330, and one out of 45 dies annually; how many die in a year?

73. A gentleman's yearly income is 19500 rupees; how much must he spend per week so that he may neither save nor borrow? (There are 52 weeks in a year).

74. A ship sails 125 miles a day; how long will it take to sail a distance of 32000 miles?

75. 2750 bottles are to be packed in boxes, each holding 125 bottles: how many boxes will be required?

SHORT DIVISION.

42. The process of division may be greatly shortened when the divisor does not exceed 20.

Example. Divide 8259 by 6.

$$\begin{array}{r} 6\ )\ \underline{8259} \\ \text{quot. } 1376\text{, rem. } 3. \end{array}$$

We draw a line under the dividend, and under this we set down the successive figures of the quotient, the multiplication, subtraction, etc. being performed mentally.

EXAMPLES. 14.

Divide, employing Short Division,

1. 34561 by 2.	**2.** 78930 by 3.	**3.** 80358 by 4.
4. 12792 by 5.	**5.** 23057 by 6.	**6.** 98400 by 7.
7. 34567 by 8.	**8.** 19870 by 9.	**9.** 34567 by 10.
10. 580046 by 11.	**11.** 807040 by 12.	**12.** 135689 by 13.
13. 450782 by 14.	**14.** 743080 by 15.	**15.** 935862 by 16.
16. 3890457 by 17.	**17.** 8207305 by 18.	**18.** 12345678 by 19.

19. Each of 3456789, 80704030 and 987654321 by 2, 3, 4, 5, 6,... 19, 20 separately.

20. Work examples 1 to 30 of *Examples* 13 by Short Division.

VII. PROPOSITIONS IN THE FUNDAMENTAL OPERATIONS.

43. To find the sum of any number of the ***natural numbers*** beginning with 1.

Rule. *Multiply the last number by the next higher number, and divide the result by* 2.

Example 1. Add together $1+2+3+4+...+15$.

Here the last number is 15, and the next higher number is 16; their product is 240: therefore the sum required $=240 \div 2=120$.

Example 2. Add together $21+22+23+...+35$.

Here, add together the numbers from 1 to 35, and also the numbers from 1 to 20; and subtract the latter sum from the former.

44. Given the sum and difference of two numbers, to find the numbers.

Rule. *To get the greater number, add the sum and difference, and divide the result by 2. To get the smaller number, subtract the difference from the sum, and divide the result by 2.*

Example 1. The sum of two numbers is 40 and their difference is 16; what is the greater number?

Process: $40+16=56$; $56 \div 2=28$ *Ans.*

Example 2. The sum of two numbers is 59 and their difference 11; what is the smaller number?

Process: $59-11=48$; $48 \div 2=24$ *Ans.*

EXAMPLES. 15.

Find the value of

1. $1+2+3+\ldots+20$.
2. $1+2+3+\ldots+30$.
3. $1+2+3+\ldots+45$.
4. $1+2+3+\ldots+75$.
5. $1+2+3+\ldots+100$.
6. $7+8+9+\ldots+50$.
7. $40+41+42+\ldots+90$.
8. $100+101+102+\ldots+200$.

9. The sum of two numbers is 376, and their difference is 114; what is the greater number?

10. Find the greater of two numbers, of which the sum is 89251 and the difference is 385.

11. The sum of two numbers is 83957, and their difference is 74821; what is the smaller number?

12. Find the smaller of two numbers, of which the sum is 79358 and the difference is 3456.

13. The sum of two numbers is 8527 and their difference is 729; find the numbers.

14. Find the two numbers, of which the sum is 10000 and the difference is 888.

45. *Multiplication by factors.*

Example 1. Multiply 329 by 35. Here $35=7\times5$.

Process:

$$\begin{array}{r} 329 \\ \underline{7} \\ 2303 \\ \underline{5} \\ 11515 \end{array} \quad \textit{Ans.}$$

Example 2. Multiply 1725 by 217, and by 721, making in each case only two partial multiplications.

(1)		(2)	
	1725		1725
	217		721
	12075		12075
	36225		36225
	374325 *Ans.*		1243725 *Ans.*

Here, we multiply by 7, and by 21; but the product by obtained by multiplying the first product by 3.

46. *Abbreviated methods of Multiplication.*

(*a*) To multiply a number by 5, annex 0 to the number, and divide the result by 2. Thus, $172 \times 5 = 1720 \div 2 = 860$.

Example. Multiply 172 by 15.

	2) 1720	=	product by 10.	(1)
	860	=	product by 5.	(2)
Adding (1) and (2),	2580	=	product by 15.	

(*b*) To Multiply a number by 25, annex 00 to the number, and divide the result by 4. Thus, $38 \times 25 = 3800 \div 4 = 950$.

Example 1. Multiply 38 by 35.

	4) 3800			
	950	=	product by 25.	(1)
	380	=	product by 10	(2)
Adding (1) and (2),	1330	=	product by 35.	

Example 2. Multiply 38 by 75.

	4) 3800	=	product by 100.	(1)
	950	=	product by 25.	(2)
Subtracting (2) from (1),	2850	=	product by 75.	

(*c*) To multiply a number by 125, annex 000 to the number, and divide the result by 8. Thus, $89 \times 125 = 89000 \div 8 = 11125$.

(*d*) To multiply a number by 9, 99, 999, 9999, ..., annex as many 0's as there are 9's in the multiplier, and from the result subtract the number itself. Thus, $345 \times 99 = 34500 - 345 = 34155$.

(*e*) To multiply by a number which differs but little from 10, 100, 1000, 10000, ..., we employ a method similar to the above.

Example. Multiply 345 by 998.

345 × 1000	=	345000
345 × 2	=	690
By subtraction,		344310 *Ans.*

47. *Abbreviated method of squaring a given number.*

If the given number contains two figures :—To and from the given number add and subtract the unit figure ; multiply the two results together, and to the product add the square of the unit figure. If the given number contains three (or more) figures, take from the end two (or more) figures instead of the unit figure.

Example 1. Find the square of 47.

$$47+7=54\ ;\ 47-7=40\ ;$$
$$54\times40=2160\ ;\quad 7^2=49\ ;$$
$$\therefore\quad 47^2=2160+49\quad=2209.$$

Example 2. Find the square of 346.

$$346+46=392\ ;\ 346-46=300\ ;\ 392\times300=117600\ ;$$
$$\therefore\quad 346^2=117600+46^2.$$

Now, $46+6=52\ ;\ 46-6=40\ ;\ 52\times40=2080\ ;\ 6^2=36\ ;$

$$\therefore\quad 46^2=2080+36=2116.$$

Hence $346^2=117600+2116=119716.$

EXAMPLES. 16.

Multiply, using factors not greater than 20,

1. 728 by 24. **2.** 8025 by 42. **3.** 9345 by 72.
4. 921 by 144. **5.** 872 by 280. **6.** 742 by 128.

Obtain the following products by two lines of multiplication only.

7. 7925×328. **8.** 825×729. **9.** 3842×321.
10. 392×366. **11.** 526×848. **12.** 734×4812.

13. Obtain the product of 2356 by 125255 by three lines of multiplication.

14. Multiply 8273 by 147497 making only three partial multiplications.

Obtain the following products by the method of Art. 46.

15. 725×5. **16.** 329×5. **17.** 812×5. **18.** 84×25.
19. 729×25. **20.** 92×25. **21.** 98×125. **22.** 125×125.
23. 207×125. **24.** 112×99. **25.** 282×999. **26.** 204×9999.
27. 421×998. **28.** 4268×980. **29.** 827×9997.
30. 739×50. **31.** 371×15. **32.** 892×35.
33. 709×75. **34.** 304×15. **35.** 789×75.

Find, by the method of Art. 47, the square of

36. 35. **37.** 55. **38.** 86. **39.** 97.
40. 325. **41.** 465. **42.** 779. **43.** 896.

48. *Division by factors.*

Example 1. Divide 15792 by 48. Here $48 = 8 \times 6$.

Process :

$$\begin{array}{r|l} 8 & \underline{15792} \\ 6 & \underline{1974} \\ & 329 \text{ quotient.} \end{array}$$

Example 2. Divide 934 by 24.

(A)

$$\begin{array}{r|l} 4 & \underline{934} \\ 6 & \underline{233} \ldots 2 \\ & 38 \ldots 5 \end{array}$$

The quotient is 38.

The remainder = 5 groups of 4 units + 2 units = 20 + 2 = 22.

(B)

$$\begin{array}{r|l} 4 & \underline{934} \\ 3 & \underline{233} \ldots 2 \\ 2 & \underline{77} \ldots 2 \\ \text{qt.} & 38 \ldots 1 \end{array}$$

Remainder $= 2 + (2 \times 4) + (1 \times 4 \times 3)$
$= 22.$

In all cases,

The true remainder = 1st R + (2nd R × 1st dvr.)
+ (3rd R × 1st dvr. × 2nd dvr.) + etc.

49. *Abbreviated methods of Division.*

(1) To divide a number by 10, 100, 1000,.........,cut off one, two, three,........., figures from the right of the number ; the figures cut off will give the Remainder and the remaining figures the Quotient. Thus, when we divide 53274 by 100, the quotient is 532, and the remainder is 74.

(2) To divide by any number ending with ciphers, cut off the ciphers from the divisor and as many figures from the right of the dividend ; then divide the remaining figures of the dividend by the remaining figures of the divisor, and to the remainder annex the figures cut off from the dividend to get the total remainder. Thus, if we have to divide 3754 by 700, we divide 37 by 7, which gives 5 as quotient and 2 as remainder ; the total remainder is 254.

(3) To divide a number by 5, 15, 35 or 45, multiply the number by 2 and divide the result by 10, 30, 70 or 90 (by the above method) ; divide the remainder by 2 to get the true remainder. Thus to divide 78 by 5, we multiply 78 by 2, getting 156 as the result ; this divided by 10 gives 15 as quotient and 6 as remainder ; the true remainder is $6 \div 2$ or 3. Hence 78 divided by 5 gives 15 as quotient and 3 as remainder.

(4) To divide a number by 25 or 75, multiply the number by 4 and divide the result by 100 or 300 ; divide the remainder by 4 to get the true remainder.

(5) To divide a number by 125, multiply the number by 8 and divide the result by 1000 ; divide the remainder by 8 to get the true remainder.

EXAMPLES. 17.

In the following examples employ Short Division.

1. $936 \div 24$.	2. $736 \div 32$.	3. $1890 \div 45$.
4. $2856 \div 42$.	5. $3312 \div 144$.	6. $8274 \div 25$.
7. $38920 \div 72$.	8. $23456 \div 63$.	9. $74829 \div 99$.
10. $82034 \div 121$.	11. $704568 \div 240$.	12. $824506 \div 8^2$.
13. $123456 \div 7^3$.	14. $987654 \div 480$.	15. $888888 \div 5^4$.

Divide by the method of Art. 49 :

16. $3894 \div 10$.	17. $3456 \div 100$.	18. $89345 \div 1000$.
19. $82746 \div 100$.	20. $89346 \div 1000$.	21. $123456 \div 10000$.
22. $3892 \div 30$.	23. $7892 \div 50$.	24. $98467 \div 800$.
25. $73563 \div 1900$.	26. $736894 \div 16000$.	27. $9876543 \div 12600$.
28. $354693 \div 2900$.	29. $7689246 \div 790$.	30. $9234587 \div 3400$.
31. $378 \div 5$.	32. $4689 \div 5$.	33. $1276 \div 5$.
34. $7845 \div 25$.	35. $82769 \div 25$.	36. $137892 \div 25$.
37. $83764 \div 125$	38. $137891 \div 125$.	39. $3792 \div 125$.
40. $374 \div 15$.	41. $789 \div 35$.	42. $921 \div 45$.
43. $1234 \div 75$.	44. $1394 \div 65$.	45. $9246 \div 85$.

50. The process of multiplication and subtraction may be combined in a question like the following :

Example. Subtract 7 times 347 from 3283.

Mental process : 7 times 7 is 49 ; 49 and **4** are 53 : *carry* 5 and 7 times 4 are 33 ; 33 and **5** are 38 ; *carry* 3 and 7 times 3 are 24 ; 24 and **8** are 32.

$$\begin{array}{r} 3283 \\ 347 \\ 7 \\ \hline 854 \end{array}$$

Note. The above method may be very advantageously employed in the process of division.

Example. Divide 8422 by 34.

Here, by the method of the above example, we multiply 34 by 2, subtract the product from 84 and set down only the remainder 16 ; and so on.

$$\begin{array}{l} 34\ )\ 8422\ (\ 247 \\ \quad\ \ \ 162 \\ \quad\ \ \ \ 262 \\ \quad\ \ \ \ \ \ 24 \end{array}$$

EXAMPLES. 18.

Subtract

1. 329×8 from 4827.	2. 732×9 from 82170.
3. 3798×6 from 894670.	4. 9378×7 from 369812.

5. 7384 × 11 from 100000. 6. 369 × 12 from 89468.

Add

7. 389 × 4 to 39. 8. 894 × 9 to 786.

9. 7345 × 12 to 3940. 10. 39874 to 329 × 16.

In the following examples use the method of Art. 50.

11. 3798 ÷ 76. 12. 38875 ÷ 329. 13. 82456 ÷ 729.

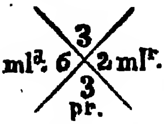
14. 760820 ÷ 378. 15. 3456789 ÷ 3246. 16. 3450789 ÷ 3

CASTING OUT THE NINES.

51. The following method called **"casting out the nines"** is frequently employed in testing the correctness of the result of multiplication.

Divide the sum of the digits in the multiplicand by 9 and set down the remainder; do the same thing with the multiplier; multiply the two remainders together, divide the result by 9, and set down the remainder; then if the multiplication has been performed correctly, the last remainder will be the same as the remainder obtained by dividing the sum of the digits in the product by 9.

Example. 186 × 47 = 8742.



The sum of digits in 186 = 15; 15 ÷ 9 gives rem. 6; the sum of digits in 47 = 11; 11 ÷ 9 gives rem. 2; 6 × 2 = 12; 12 ÷ 9 gives rem. 3.
Sum of digits in 8742 = 21; 21 ÷ 9 gives rem. 3.

N. B. This test will fail if such a mistake has been committed, as does not affect the sum of the digits of the product, or, increases or decreases it by 9 or a multiple of 9.

EXAMPLES. 19.

Multiply, and test the result of multiplying

1. 3756 by 738. 2. 8943 by 826. 3. 3789 by 989.

4. 30804 by 3080. 5. 78093 by 8034. 6. 73980 by 3001.

7. 39400 by 3900. 8. 803075 by 390. 9. 823794 by 8234.

MISCELLANEOUS EXAMPLES. 20.

1. What number must be added to 3452 to make 6000?

2. What number must be taken from 3021 to leave 999?

3. The sum of two numbers is 8920, and the smaller number is 309; what is the greater number?

4. The difference between two numbers is 379, and the greater number is 1000 ; what is the smaller ?

5. The difference between two numbers is 79, and the smaller number is 709 ; what is the greater number ?

6. What is the difference between the least number of five figures and the greatest number of three figures ?

7. The dividend is 3792, the quotient 12 and the remainder 0 ; find the divisor.

8. What number multiplied by 304 will produce 3344 ?

9. The divisor is 321, the quotient 11 and the remainder 260 ; find the dividend.

10. What is the divisor when the dividend is 345, the remainder 5 and the quotient 20 ?

11. Find the sum of all the numbers of 3 digits, which you can form with the figures 3, 0, 4.

12 Find the difference between the greatest and the least number of 4 digits, that you can form with the figures 3, 2, 7, 8.

13. There are two numbers, of which the product is 7243491, and the greater number is 34007 ; find the difference between the two numbers.

14. Find the sum of the products, two and two, of 369, 217 and 648.

15. How many times can 23 be subtracted from 920550, and what will be the final remainder ?

16. The product of two numbers is 173432, and half of one of them is 163 ; what is the other ?

17. The product of two numbers is 123904, and double of one of them is 1408 ; what is the other ?

18. How many times in succession must 201 be added to 3166 to make the final sum 10000 ?

19. How much must be added to the product of 75 and 83 to give the product of 75 and 85 ? How much must be subtracted to give the product of 74 and 83 ?

20. How often does the sum of 3692 and 2769 contain their difference ?

21. What number multiplied by 371 will give the same product as 185 multiplied by 309 ?

22. In a division sum the divisor is 5 times and the quotient is 6 times the remainder which is 73 ; what is the dividend ?

23. If, in dividing a number by 105, the operation be performed by short division by employing factors 3, 5, 7 in succession, and the several remainders be 2, 4, 5, what is the complete remainder ?

24. If when a number is divided continuously by 7, 8 and 9 the remainders are 5, 3 and 6 respectively, what would be the remainder if the same number were divided by the continued product of 7, 8 and 9?

25. The quotient is 702, the remainder is 24, and the divisor 7 more than the sum of both: what is the dividend?

26. The sum of two numbers is 205, and one of them exceeds the other by 7; what are the numbers?

27. Your age is 12 years; your brother's age is 19 years; what will be your brother's age when you are 16 years old?

28. Find the sum of three numbers, the first of which is made up of 3908 and 78904, the second of which exceeds the first by 1740, and the third exceeds the difference of the other two by 7809.

29. There are two numbers; the less is 94567, and the other exceeds it by 327; what is their sum?

30. I have 3290 rupees in cash, 75000 rupees in Government promissory notes; I owe 3525 rupees to *A* and 25 rupees less to *B*: how much am I worth?

31. The sum of two numbers is 729, the less is 57; what is their difference?

32. What number must be subtracted from the product of 329 and 412 to make it equal to their sum?

33. A man sold 260 mangoes at 2 pice each, and 50 oranges at the rate of two for a pice; how many pice did he get in all?

34. Obtain the product of 3749 by 216636 by three lines of multiplication.

35. Multiply 7384 by 42428 in three lines.

36. If I had 300 rupees more, I could have paid a debt of 750 rupees and have 25 rupees over; how much have I?

37. In a game of cricket *A*, *B* and *C* together score 134 runs; *B* and *C* together score 76 runs; and *A* and *C* together score 100 runs; find the number of runs scored by each.

38. *A* and *B* together have 79 rupees, *C* has 49 rupees less than what *A* and *B* together have, and *B* has 9 rupees more than *C*; find what each has.

39. I bought a dog for 25 rupees, a cat for 15 rupees less, and a horse for 30 rupees more than twice the price of the cat and dog; how much did I spend in all?

40. A man, after selling oranges to three purchasers, found that he had a rupee worth left; if he had sold 5 more oranges to each purchaser he would have only 3 left: at what rate per rupee did he sell the oranges?

41. A cistern has two pipes attached to it ; by one of the pipes 24 seers of water enter into the cistern per minute, and by the other 14 seers go out in the same time : how much water will there be in the cistern if both the pipes are left open for 6 minutes? Also find how much the cistern holds if the empty cistern be filled in 10 minutes when both the pipes are open.

42. A gentleman's monthly income amounts to 250 rupees, and his monthly expenses amount to 175 rupees ; how much will he be able to save at the end of 2 years? [A year = 12 months.]

43. A man's age is 59 years ; his brother is 7 years older than he, and his sister 12 years younger than his brother : what was the man's age when his sister was born?

44. A man was 30 years old when his eldest son was born ; how old will his son be when he is 40 years old, and what will be the man's age when the son is 40 years old?

45. Find a number such that if it be added 12 times to 60 the sum will be 780.

46. The distance from Calcutta to Goalundo is 152 miles ; a train starts from Calcutta at 7 A. M., and runs towards Goalundo at the rate of 19 miles an hour : at what o'clock will it arrive there?

47. Take any number, subtract from it the sum of its digits ; the result will be divisible by 9 without remainder.

48. If any number and the sum of its digits be each divided by 9, the remainders will be equal.

49. Take any number, multiply it by 2, add 16 to the product, divide the sum by 2, subtract the original number from the quotient ; the remainder will be 8.

50. The product of any three consecutive numbers is divisible by 6 without remainder.

VIII. MEASURES OF MONEY AND REDUCTION.

52. In practice it is found convenient to use large units for measuring large quantities, and small units for measuring small quantities. Thus, we say that the price of a table is 20 rupees ; the price of a book is 10 annas ; the price of a toy is 3 pice.

A list of the relative magnitudes of the various units used for the measurement of quantities of the same kind is called a Table.

53. English Money Table.

4 Farthings (*q.*) make		1 Penny (1*d.*).
12 Pence	...	1 Shilling (1*s.* or 1/-).
20 Shillings	...	1 Pound or Sovereign (£1).

2 Shillings = 1 Florin.	5 Shillings = 1 Crown.
21 Shillings = 1 Guinea.	27 Shillings = 1 Moidore.

Note. 1, 2 and 3 farthings are usually indicated by $\frac{1}{4}d.$, $\frac{1}{2}d.$ and $\frac{3}{4}d.$ respectively.

The following coins are now in circulation in England :

Copper coins :—a farthing, a half-penny, a penny.

Silver coins :—a threepenny piece, a fourpenny piece (or *groat*), a sixpence (or *tester*), a shilling, a florin, a half-crown, a crown.

Gold coins :—a half-sovereign, a sovereign.

The following gold coins are now obsolete but were in circulation at various periods in England :—a noble (6*s*. 8*d*.), an angel (10*s*.), a half-guinea (10*s*. 6*d*.), a mark or merk (13*s*. 4*d*.), a guinea (21*s*.), a carolus (23*s*.), a jacobus (25*s*.), a moidore (27*s*.).

The *standard* of gold coin in England is 22 parts of pure gold and 2 parts of copper, melted together. Each of these 24 parts is called a *carat*. Pure gold is said to be 24 carats *fine* and standard gold 22 carats *fine*. From a pound Troy of standard gold there are coined $46\frac{29}{40}$ sovereigns, or £46. 14*s*. 6*d*. The *standard* of silver coin is 37 parts of pure silver and 3 parts of copper. From a pound Troy of standard silver there are coined 66 *shillings*. In copper coinage 24 pennies are coined from one pound Avoirdupois of copper.

Gold coinage is the standard in England. Silver coinage is not a *legal tender* for more than 40*s*., nor is copper coinage for more than 12*d*

54. Indian Money Table.

3 Pies (*p*)	make	1 Pice.
4 Pice or 12 Pies	...	1 Anna. (1*a*.).
16 Annas	...	1 Rupee (R1).

A gold *Mohur* is a gold coin whose weight is equal to that of a rupee. Its value in silver money is variable. In paying Doctors' fees a gold mohur means R16, and in paying Lawyers' fees, R17.

15 Sicca Rupees	=	16 Current Rupees.
100 Raes of Bombay	=	A quarter-rupee.
100 Cents of Ceylon	=	1 Rupee.
A Pagoda of Madras	=	R3. 8*a*.

Copper coins :—a pie, a half-pice, a pice, a double-pice.

Silver coins :—a two-anna piece, a four-anna piece or quarter-rupee, an eight-anna piece or half-rupee, a rupee.

Gold coins :—a five-rupee piece, a ten-rupee piece, a gold mohur or fifteen rupee piece, a double gold mohur or thirty-rupee piece.

The *standard* of gold or silver coin in India is 11 parts of pure gold or silver and 1 part of alloy. The weight of a rupee or of a gold mohur = 180 grains Troy. A double-pice weighs 200 grains Troy.

Gold coinage is not a *legal tender* in India : the rupee and half-rupee are *legal tender* for any amount, other silver coins and the copper coins being a *legal tender* for the fractions of a rupee only.

A rupee is approximately equivalent to 2 shillings, but its value in English money is variable.

In keeping accounts in Bengali the following Table is in common use :

4	Cowries	make	1	Ganda.
5	Gandas	...	1	Buri, Paisa or Pice.
4	Buris or 20 Gandas	...	1	Pan or Anna.
4	Pans	...	1	Chouk or Quarter-rupee.
4	Chouks	...	1	Kahan or Rupee.

One Cowry = 3 Krantis = 4 Kags = 5 Tals = 7 Dwips = 9 Dantis = 27 Jabs = 80 Tils.

The following Table gives the sub-divisions of a pice, as used in Behar, North-Western Provinces and the Punjab :

2 Addhis = 1 Damri ; 2 Damris = 1 Chidam ;
2 Chidams = 1 Adhela ; 2 Adhelas = 1 Paisa or pice.

REDUCTION.

55. A quantity expressed by means of a single unit is called a **simple quantity**. A quantity expressed by means of more than one unit is called a **compound quantity**. Thus, R7 is a simple quantity ; R3. 4*a.* 3*p.* is a compound quantity.

Reduction is the process by which we express (1) a simple or a compound quantity in terms of a lower unit, or (2) a simple quantity in terms of higher units.

56. I. DESCENDING REDUCTION.

Example 1. Reduce R34. 7*a.* 6*p.* to pies.

Since R1 = 16*a.*, R34 = (34 × 16)*a.* = 544*a.*

∴ R34. 7*a.* = 544*a.* + 7*a.* = 551*a.*

Again, since 1*a.* = 12*p.*, 551*a.* = (551 × 12) *p.* = 6612*p.*

∴ R34. 7*a.* 6*p.* = 6612*p.* + 6*p.* = 6618*p.* *Ans.*

In practice the operations of multiplication and addition are combined, and the process stands thus :

```
 R.    a.   p.
 34 .  7 .  6
 16
 ----
 551a.
  12
 ----
6618p.  Ans.
```

Example 2. Reduce £3. 7*s*. $4\frac{1}{2}$*d*. to farthings.

Process :

£.	*s*.	*d*.
3	7	$4\frac{1}{2}$
20		
67*s*.		
12		
808*d*.		
4		
3234*q*. *Ans*.		

EXAMPLES. 21.

Reduce to annas :

1. R39. **2.** R104. **3.** R7208. **4.** R3698.
5. R7. 9*a*. **6.** R23. 4*a*. **7.** R37. 12*a*. **8.** R51. 14*a*.

Reduce to pies :

9. R309. **10.** R740. **11.** R3402.
12. R201. 9*a*. **13.** R112. 10*a*. **14.** R704. 13*a*.
15. R27. 0*a*. 3*p*. **16.** R39. 12*a*. 9*p*. **17.** R67. 15*a*. 11*p*.

Reduce (i) to pice and (ii) to pies :

18. R3. 0*a*. 2 *pice*. **19.** R7. 13*a*. 1 *pice*. **20.** R9. 14*a*. 3 *pice*.

Reduce

21. R3705 to half-rupees. **22.** R408 to quarter-rupees.
23. R78. 14*a*. to two-anna pieces. **24.** R3. 2*a*. to double-pice.
25. R30. 7*a*. to half-pice. **26.** R7. 8*a*. 6*p*. to pice.

Reduce to shillings :

27. £720. **28.** £240. **29.** £709. **30.** £305.
31. £20. 5*s*. **32.** £26. 12*s*. **33.** £30. 17*s*. **34.** £35. 19*s*.

Reduce to pence :

35. £35. **36.** £670. **37.** £7020.
38. £45. 11*s*. **39.** £50. 13*s*. **40.** £76. 15*s*.
41. £3. 12*s*. 6*d*. **42.** £9. 0*s*. 10*d*. **43.** £7. 16*s*. 11*d*.

Reduce to farthings :

44. £1000. **45.** £305. 17*s*. **46.** £7. 12*s*. 9*d*.
47. £3. 7*s*. $3\frac{1}{4}$*d*. **48.** £7. 0*s*. $9\frac{1}{2}$*d*. **49.** £2. 16*s*. $0\frac{3}{4}$*d*.

Reduce (i) to crowns, (ii) to sixpences and (iii) to fourpences :

50. £9. 5*s*. **51.** £10. 10*s*. **52.** £15. 15*s*.

Reduce

53. £2. 7*s.* 6*d.* to half-crowns. **54.** £3. 3*s.* 9*d.* to threepences.

55. 300 half-crowns to farthings. **56.** 56 guineas to half-pence.

57. If the price of an orange be one pice, how many can you buy for R1. 9*a.* ?

58. A debt of £2. 7*s.* $7\frac{1}{2}$*d.* is to be paid in farthings ; how many will be required ?

59. How many one-anna books can be bought with R7. 13*a.* ?

60. For how many children can a treat be provided with R13. 12*a.* at 4*a.* a head ?

61. I gave away £1. 13*s.* to a number of beggars, giving a penny to each ; how many beggars were there ?

57. II. ASCENDING REDUCTION.

Example 1. Reduce 1995 pies to R. *a p.*

Process :

12) 1995*p.*
16) 166*a.* + 3*p.* rem.
R10. + 6*a.* rem.

Answer. R10. 6*a.* 3*p.*

Example 2. Reduce 15723 farthings to £. *s. d.*

Process :

4) 15723*q.*
12) 3930*d.* + 3*q.* rem.
20) 327*s.* + 6*d.* rem.
£16 + 7*s.* rem.

Answer. £16. 7*s.* $6\frac{3}{4}$*d.*

EXAMPLES. 22.

Reduce to R. *a. p.*

1. 10000 *pies.* **2.** 30793 *pies.* **3.** 77777 *pies.*

4. 3948 *pies.* **5.** 7823 *pies.* **6.** 11111 *pies.*

7. 30303 *pies.* **8.** 47474 *pies.* **9.** 10001 *pies.*

10. 1000 *pice.* **11.** 3785 *pice.* **12.** 3082 *pice.*

13. 7082 *half-pice.* **14.** 8936 *half-pice.* **15.** 3840 *double-pice.*

Reduce to £. *s. d.* :

16. 376 *pence.* **17.** 7023 *pence.* **18.** 8920 *pence.*

19. 1000 *farthings.* **20.** 10008 *farthings.* **21.** 3333 *farthings.*

22. 8040 *farthings.* **23.** 7929 *farthings.* **24.** 4408 *farthings.*

25. 379 *half-pence.* **26.** 3940 *threepences.* **27.** 27 *guineas.*
28. 390 *half-crowns.* **29.** 396 *sixpences.* **30.** 30 *moidores.*

31. I paid one pice to each of 1960 beggars; how many rupees did I spend?

32. How much money will be required to buy 300 quarter-anna post cards?

33. If you buy 720 oranges at one farthing each, how many shillings shall you have to pay to the fruit-seller?

IX. COMPOUND ADDITION.

58. The following example will illustrate the method of adding together compound quantities.

Example. Add together £3. 7*s.* 4½*d.*, £8. 2*s.* 7¼*d.*, £0. 19*s.* 9¼*d.* and £2. 12*s.* 8¾*d.*

We first add the farthings, and we find that there are 7 farthings; and this being equivalent to 1*d.* + 3*q.*, we place ¾ under the column of farthings and carry 1*d.* Next we add the pence, and we find that there are (with 1*d.* carried) 29 pence, and this being equivalent to 2*s.* + 5*d.*, we place 5 under the column of pence and carry 2*s.* And so on.

£.	s.	d.	
3	7	4½	
8	2	7¼	
9	19	9¼	
2	12	8¾	
£24	2	5¾	*Ans*

EXAMPLES. 23.

	a.	pice.		a.	pice.		a.	pice.		a.	pice.
1.	3	2	**2.**	8	3	**3.**	12	3	**4.**	13	2
	7	3		12	1		7	1		10	3
	9	2		14	2		13	2		9	0
	6	3		10	3		15	3		8	1

	a.	p.		a.	p.		a.	p.		a.	p.
5.	9	9	**6.**	12	10	**7.**	7	6	**8.**	8	3
	10	4		7	7		12	7		9	11
	7	0		11	11		14	10		15	7
	13	11		14	8		13	4		12	9

	R.	a.	p.		R.	a.	p.		R.	a.	p.
9.	9	12	3	**10.**	12	13	3	**11.**	22	12	3
	15	7	1		7	12	9		33	13	8
	9	0	2		20	8	7		14	14	0
	10	2	3		31	14	3		3	9	2
	8	7	0		12	12	0		7	7	11

12.

R.	a.	pice.
13	7	3
107	13	2
39	12	1
7	0	3
19	14	0
12	8	1
317	9	2

13.

R.	a.	p
8	7	9
11	11	11
309	14	8
39	0	10
604	8	4
89	13	4
824	7	2

14.

R.	a.	p.
100	13	4
29	7	8
7	12	3
309	0	11
70	7	9
770	7	7
86	9	10

15.

R.	a.	p.
8	8	8
17	4	7
309	12	11
1234	13	10
239	8	9
26	4	3
7	3	6
29	14	5
100	7	8

16.

R.	a.	p.
349	15	4
1207	13	8
740	9	6
39	4	9
123	12	11
8	7	10
1286	13	7
836	9	2
63	10	8

17.

R.	a.	p.
896	9	8
64	11	2
42	9	11
4276	13	4
7624	3	7
72	8	3
726	12	10
3725	7	8
340	10	5

18.

R.	a.	p.
76	9	7
1249	12	3
3400	15	8
313	6	9
82	8	0
7	9	4
743	11	10
376	13	11
8824	6	5
7286	5	4
510	10	0
36	7	2
9	9	9
982	2	1

19.

R.	a.	p.
374	12	3
483	13	7
7682	14	6
300	15	4
82	11	10
4	10	8
92	0	9
7	4	5
89	7	8
345	9	2
9876	3	6
4242	8	11
123	6	3
99	5	9

20.

R.	a.	p.
3846	9	11
8463	11	9
768	10	2
968	13	6
39	4	7
46	6	0
7	9	9
8	12	3
12	14	4
10	8	8
346	3	7
789	2	6
1234	1	4
5678	7	2

21.

£.	s.	d.
7	12	3
19	19	7
100	13	9
76	7	8
304	8	2

22.

£.	s.	d.
39	18	10
76	2	9
300	17	3
49	16	8
4	3	6

23.

£.	s.	d.
100	13	9
376	3	3
489	14	7
39	4	6
4	9	8

24.

£.	s.	d.
392	8	$3\frac{3}{4}$
76	9	9
1396	7	$8\frac{1}{4}$
300	13	2
39	19	$1\frac{1}{2}$
4	12	3
7892	10	$4\frac{3}{4}$

25.

£.	s.	d.
9	12	$0\frac{1}{2}$
72	4	$8\frac{3}{4}$
384	17	$7\frac{1}{4}$
4782	6	2
400	19	$3\frac{1}{2}$
92	13	$4\frac{3}{4}$
4	6	$6\frac{3}{4}$

26.

£.	s.	d.
346	19	$3\frac{1}{4}$
46	12	$4\frac{3}{4}$
39	13	$6\frac{1}{2}$
4	8	$7\frac{1}{2}$
9	12	$0\frac{1}{4}$
13	14	$4\frac{1}{2}$
5	12	$0\frac{3}{4}$

27.

£.	s.	d.
3	4	$5\frac{1}{2}$
13	14	$10\frac{1}{4}$
527	19	$7\frac{3}{4}$
12	13	$3\frac{1}{2}$
5	7	$8\frac{3}{4}$
8	9	$6\frac{1}{2}$
5	12	$0\frac{3}{4}$
300	15	$10\frac{1}{2}$

28.

£.	s.	d.
300	1	$0\frac{1}{2}$
29	5	3
31	7	$2\frac{1}{2}$
4	13	$5\frac{1}{2}$
5	15	$7\frac{3}{4}$
6	19	$9\frac{1}{4}$
81	12	$11\frac{3}{4}$
390	11	$0\frac{1}{4}$

29.

£.	s.	d.
432	9	9
73	12	$2\frac{1}{2}$
820	13	$0\frac{3}{4}$
70	14	$9\frac{3}{4}$
8	15	2
9	16	$3\frac{1}{2}$
12	17	4
329	18	$7\frac{1}{4}$

X. COMPOUND SUBTRACTION.

59. The method of subtracting one compound quantity from another is as follows :

Example. Subtract R7. 9*a.* 6*p.* from R12. 3*a.* 9*p.*

Here we have to find the quantity which being added to R7. 9*a.* 6*p.* makes up R12. 3*a.* 9*p.* We see that 6*p.* + 3*p.* = 9*p.* ; we therefore put down 3 under the column of *pies*. Next, 9*a.* + 10*a.* = 19*a.* = R1 + 3*a.* ; we put down 10 under the column of *annas* and carry R1 for adding to the *rupees of the subtrahend* : now, R1 (*carried*) + R7 + R4 = R12 ; and we place 4 under the column of rupees.

R.	*a.*	*p.*
12	3	9
7	9	6
R4	10	3 *Ans.*

EXAMPLES. 24.

Subtract

1. R7. 9*a.* 2 *pice.* from R13. 12*a.* 3 *pice.*
2. R28. 12*a.* 3 *pice.* from R30. 9*a.* 2 *pice.*
3. R3. 9*a.* 1 *pice* from R13. 4*a.* 4. R9. 7*a.* 6*p.* from R13. 3*a.* 3*p.*
5. R39. 13*a.* 9*p.* from R79. 12*a.* 6*p.*
6. R3. 7*a.* 8*p.* from R13. 7. R13. 12*a.* 7*p.* from R29.
8. R14. 14*a.* 9*p.* from R15. 12*a.* 9. R69. 15*a.* 2*p.* from R80. 8*a.*

10. R91. 12*a*. 11*p*. from R150. 0*a*. 7*p*.
11. R726. 15*a*. 5*p*. from R1000. 13*a*. 4*p*.
12. R109. 10*a*. 3*p*. from R110. 0*a*. 9*p*.
13. £7. 17*s*. 9*d*. from £13. 7*s*. 4*d*.
14. £13. 16*s*. 7½*d*. from £27. 12*s*. 4¼*d*.
15. £45. 19*s*. 11¾*d*. from £65. 18*s*. 8½*d*. **16.** £7. 7*s*. 7½*d*. from £10.
17. £13. 13*s*. 8¾*d*. from £15. 17*s*. 0½*d*.
18. £37. 7*s*. 6¼*d*. from £49. 0*s*. 3*d*.
19. £96. 4*s*. 10¾*d*. from £104. 0*s*. 0½*d*.
20. £102. 19*s*. 11¼*d*. from £105. 7*s*. 0¾*d*.
21. £67. 11*s*. 4¾*d*. from £98. 6*s*. 2¼*d*
22. £98. 18*s*. 4½*d*. from £908. 5*s*. 2¼*d*
23. £275. 15*s*. 5½*d*. from £743 0*s*. 4¾*d*.
24. £492. 18*s*. 8¾*d*. from £611. 17*s*. 2½*d*.

XI. COMPOUND MULTIPLICATION.

60. *Compound Multiplication* is a short method of finding the sum of a certain number of repetitions of a given compound quantity.

The process is as follows:

Example. Multiply R5. 12*a*. 4*p*. by 7, and by 35.

R.	*a*.	*p*.
5	12	4
		7
R40	6	4 *Ans.*

7 times 4*p*. = 28*p*. = 2*a*. + 4*p*.; set down 4 and carry 2. 7 times 12*a*. = 84*a*., which with 2*a*. *carried* = 86*a* = R5 + 6*a*.; set down 6 and carry 5. 7 times R5 = R35; this with R5 *carried* gives R40; and setting down this, the required product is R40. 6*a*. 4*p*.

Note. To multiply by 35 we multiply first by 7 and the product by 5.

EXAMPLES. 25.

Multiply

1. R3. 8*a*. 3 *pice* by 3, 5, 7. **2.** R9. 12*a*. 6*p*. by 5, 7, 9.
3. R39. 14*a*. 11*p*. by 11, 13, 16. **4.** £29. 18*s*. 9*d*. by 3, 7, 9.
5. £37. 15*s*. 4¾*d*. by 6, 8, 13. **6.** £40. 7*s*. 10½*d*. by 5, 9, 12.

[In the following examples use the method of multiplication by factors.]

7. R2. 4*a*. 2 *pice* by 21, 32, 25. **8.** R39. 12*a*. 9*p*. by 56, 99, 100

9. R48. 13*a*. 8*p*. by 125, 121, 144.
10. £34. 16*s*. 2½*d*. by 81, 64, 800.
11. £48. 13*s*. 0¾*d*. by 99, [illegible]420.

Find the value of

12. 9 things at 3*a*. 4*p*. each.
13. 56 things at R2. 4*a*. each.
14. 81 things at 2*s*. 6*d*. each.
15. 100 things at 7*s*. 6½*d*. each.
16. 1000 yards of broadcloth at R5. 7*a*. 6*p*. per yard.
17. 700 copies of a book at 7*s*. 7½*d*. each.
18. 3000 maunds of wheat at R3. 5*a*. 6*p*. per maund.

61. When the multiplier is a large number and cannot be split up into factors, the following method should be used.

Example. Multiply R12. 8*a*. 7*p*. by 473.

Process :

	R.	a.	p.	
	12	8	7	
			10	
	125	5	10	
			10	
	1253	10	4	
			4	
	5014	9	4	product by 400.
Multiplying 3rd line by 7,	877	8	10	... ... 70.
Multiplying 1st line by 3,	37	9	9	... ... 3.
Adding last 3 results,	R5929	11	11	product by 473.

EXAMPLES. 26.

Multiply

1. R3. 4*a*. 2 *pice* by 23, 37.
2. R7. 12*a*. 9*p*. by 37, 47.
3. R3. 13*a*. 6*p*. by 421, 704.
4. R2. 12*a*. 3*p*. by 2175, 3070.
5. £4. 7*s*. 6*d*. by 511, 112.
6. £3. 9*s*. 3½*d*. by 3684, 1237.
7. £6. 11*s*. 0¾*d*. by 753, 829.
8. £7. 0*s*. 1½*d*. by 1111, 1231.
9. A gentleman spends R7. 8*a*. 9*p*. every day ; how much does he spend in a year of 365 days?
10. Find the cost of 503 maunds of rice at R3. 9*a*. 3*p*. per maund.

XII. COMPOUND DIVISION.

62. The process of dividing a compound quantity by an *abstract number*, that is, of dividing it into a given number of equal parts, is as follows :

Example 1. Divide ₨138. 3*a*. 3*p*. by 29.

₨138 ÷ 29 gives ₨4 as quotient and ₨22 as remainder; this remainder, together with 3*a*. = 355*a*.:

355*a*. ÷ 29 gives 12*a*. as quotient and 7*a*. as remainder; this remainder, together with 3*p*. = 87*p*.:

87*p*. ÷ 29 gives 3*p*. as quotient and no remainder.

Hence the quotient is ₨4. 12*a*. 3*p*.

```
        R.    a.  p.
29 ) 138 . 3 . 3 ( R4.
     116
     ---
      22
      16
     ---
29 ) 355 ( 12a.
     29
     --
      65
      58
      --
       7
      12
      --
29 )  87 ( 3p.
      87
      --
```

∴ The quotient is ₨4. 12*a*. 3*p*.

EXAMPLES. 27.

Divide

1. ₨72. 3*a*. 3 *pice* by 23.	**2.** ₨286. 11*a*. 1 *pice* by 59.
3. ₨455. 14*a*. 7*p*. by 61.	**4.** ₨850. 14*a*. 4*p*. by 79.
5. ₨1025. 6*a*. 8*p*. by 80.	**6.** ₨583. 6*a*. 6*p*. by 98.
7. ₨4981. 10*a*. 3*p*. by 325.	**8.** ₨5049. 12*a*. 5*p*. by 499.
9. £97. 9*s*. 0½*d*. by 29.	**10.** £29. 6*s*. 1*d*. by 52.
11. £1279. 13*s*. 8¾*d*. by 23.	**12.** £4476. 7*s*. 7¼*d*. by 83.
13. £946. 17*s*. 1½*d*. by 279.	**14.** £860. 0*s*. 7½*d*. by 365.

In the 10 following examples use the method of Short Division.

15. ₨13. 15*a*. 8*p*. ÷ 2.	**16.** ₨225. 13*a*. 8*p*. ÷ 4.
17. ₨728. 14*a*. 6*p*. ÷ 5.	**18.** ₨1007. 10*a*. 2*p*. ÷ 7.
19. ₨329. 11*a*. 4*p*. ÷ 8.	**20.** ₨1243. 8*a*. ÷ 9.
21. £29. 7*s*. 6¾*d*. ÷ 3.	**22.** £333. 19*s*. 3*d*. ÷ 6.
23. £378. 16*s*. 10*d*. ÷ 8.	**24.** £3781. 0*s*. 9¾*d*. ÷ 9.

Employ the method of Division by Factors in the 6 following examples.

25. ₨27. 10*a*. ÷ 24.	**26.** ₨160. 0*a*. 3*p*. ÷ 49.
27. ₨323. 2*a*. 8*p*. ÷ 56.	**28.** ₨683. 2*a*. 6*p*. ÷ 54.
29. £3522. 1*s*. 7*d*. ÷ 28.	**30.** £543. 11*s*. ÷ 42.

31. The price of 140 quires of paper is ₨32. 13*a*.; find the price of one quire.

32. If 55 copies of a book are sold for R34. 6*a.*, what is the price of a single copy ?

33. If the cost of 2880 articles be R480, what is the cost of one article ?

34. A man's wages for 30 days are £5. 5*s.* ; what does he earn per day ?

Note. When the divisor is 10, 100, 1000,......, the following method should be used.

Example 2. Divide R1345. 13*a.* 4*p.* by 100.

The division in each step is effected by cutting off the two figures from the right; the figures cut off give the remainder and the remaining figures give the quotient [See Art. 49, (1)].

```
        R.      a.  p.
100) 13,45    13 . 4 (R13. 7a. 4p. Ans.
        16
   a. 7,33
        12
   p. 4,00
```

EXAMPLES. 28.

Divide

1.	R135. 12*a.* 6*p.*	by 10.	**2.**	R376. 2*a.* 4*p.*	by 10.
3.	R279. 11*a.*	by 100.	**4.**	R1245. 13*a.* 4*p.*	by 100.
5.	R4067. 11*a.* 4*p.*	by 100.	**6.**	R6100. 8*a.* 4*p.*	by 100.
7.	R203. 12*a.*	by 1000.	**8.**	R2135. 6*a.* 8*p.*	by 1000.
9.	£438. 6*s.* 8*d.*	by 10.	**10.**	£227. 16*s.* 8*d.*	by 10.
11.	£511. 2*s.* 11*d.*	by 100.	**12.**	£3007. 5*s.* 10*d.*	by 1000.

Example 3. Divide R97. 2*a.* 9*p.* into 31 equal parts.

```
     R.  a. p.
31 ) 97 . 2 . 9 ( R3.
     93
      4
     16
31 ) 66 ( 2a.
     62
      4
     12
31 ) 57 ( 1p.
     31
     26
```

Here we have a remainder (26*p.*) after division, and we observe that if the quotient, R3. 2*a.* 1*p.*, be multiplied by the divisor the

product will be less than the dividend by 26*p*.; again, if ₨3. 2*a*. 2*p*. be multiplied by the divisor the product will be greater than the dividend by $(31-26)p$. or 5*p*. The last therefore is nearest to the correct result. Hence **to the nearest pie** the result is ₨3. 2*a*. 2*p*.

RULE. When there is a remainder after division, the quotient or the quotient increased by 1*p*. is the result *correct to the nearest pie*, according as the divisor is greater or less than *twice* the number of pies in the remainder. If the divisor is equal to twice that number. both the results are equally correct.

EXAMPLES. 29.

Find, to the nearest pie, the result of dividing

1. ₨35. 7*a*. 8*p*. by 7. **2.** ₨49. 12*a*. 3*p*. by 10.
3. ₨67. 13*a*. 11*p*. by 41. **4.** ₨327. 8*a*. 6*p*. by 100.
5. ₨427. 10*a*. 7*p*. by 56. **6.** ₨394. 11*a*. 2*p*. by 100.
7. ₨727. 15*a*. 10*p*. by 67. **8.** ₨923. 14*a*. by 100.

Find, to the nearest farthing, the result of dividing

9. £27. 17*s*. 9½*d*. by 5. **10.** £42. 18*s*. 3¾*d*. by 10.
11. £333. 19*s*. 4¼*d*. by 29. **12.** £498. 15*s*. 0½*d*. by 100.
13. £557. 16*s*. 11¾*d*. by 210. **14.** £876. 12*s*. by 300.

Divide

15. ₨4912. 8*a*. 8*p*. by 24. **16.** ₨7895. 4*a*. 5*p*. by 55.
17. ₨47892. by 731. **18.** ₨98765. 9*a*. 1*p*. by 1000.
19. £7829. by 539. **20.** £85632. 10*s*. 10*d*. by 670.

63. To divide a compound quantity by another of the same kind, that is, to find how many times the latter is contained in the former, we proceed as in the following example :

Example. How many times is ₨1. 2*a*. 3*p*. contained in ₨26. 3*a*. 9*p*. ?

We reduce the compound quantities to the same *expressed* lowest denomination, and then proceed as in Simple Division.

₨1. 2*a*. 3*p*. = 219*p*. ; ₨26. 3*a*. 9*p*. = 5037*p*.

Now $5037 \div 219 = 23$.

∴ ₨1. 2*a*. 3*p*. is contained in ₨26. 3*a*. 9*p*., 23 times.

Note. The method of Art. 62 is called **partition** and the above method is called **quotition.**

EXAMPLES. 30.

How many times is

1. R15. 7*a*. 3*p*. contained in R139. 1*a*. 3*p*. ?
2. R20. 12*a*. 6*p*. ... ... R311. 11*a*. 6*p*. ?
3. R53. 10*a*. 9*p*. ... ... R1288. 2*a*. ?
4. £30. 7*s*. $3\frac{1}{2}$*d*. ... ... £637. 13*s*. $1\frac{1}{2}$*d*. ?
5. £17. 12*s*. $4\frac{3}{4}$*d*. ... ... £986. 14*s*. 2*d*. ?

Find the quotient and remainder in the division of

6. R211. 15*a*. 10*p*. by R7. 7*a*. 7*p*.
7. R376. 8*a*. 7*p*. by R17. 12*a*. 3*p*.
8. R304. 15*a*. 9*p*. by R7. 8*a*. 9*p*.
9. £784. 17*s*. 11*d*. by £23. 19*s*. $2\frac{1}{2}$*d*.
10. £976 by £9. 9*s*. $9\frac{1}{2}$*d*.

11. Divide R994. 13*a*. 3*p*. into equal parts, each of which is equal to R17. 7*a*. 3*p*.

12. Divide £286. 3*s*. 2*d*. into parts, each equal to £1. 11*s*. $1\frac{1}{4}$*d*.

13. How many maunds of flour, at R4. 8*a*. 3*p*. per maund, can be bought for R1354. 11*a*. ?

14. How many rupees of 1*s*. $4\frac{1}{2}$*d*. each are equivalent to £235. 10*s*. 9*d*. ?

15. A servant whose pay for a day is 2*a*. 6*p*., is fined 9*p*. if he comes in late, and at the end of 20 days he receives R2. 12*a*. 9*p*.; how often was he late ?

16. Multiply R18957. 13*a*. by R189. 9*a*. 3*p*.; and divide the same sum by the same sum. Shew that one of these operations is absurd and impossible, and perform the other.

XIII. MEASURES OF WEIGHT.

English Jewellers' or Troy Weight.

(*Chiefly used for weighing gold, silver and jewels.*)

24 Grains (gr.) make 1 Pennyweight (1 dwt.).
20 Pennyweights ... 1 Ounce (1 oz.).
12 Ounces ... 1 Pound (1 lb.).

So that a Pound Troy = 5760 Grains.

Diamonds and other precious stones are weighed by *carats*, each carat weighing about $3\frac{1}{6}$ grains.

EXAMPLES. 31.

Reduce to grains :

1. 207 lb. 2. 29 lb. 8 oz. 3. 3 lb. 9 oz. 13 dwt. 15 gr.
4. 28 lb. 7 oz. 15 dwt. 5. 55 lb. 6 oz. 9 dwt. 6. 7 lb. 3 oz. 4 dwt. 9 gr.

Reduce to lb., etc. :

7. 7845 gr. 8. 8923 gr. 9. 57892 gr. 10. 100000 gr.

Addition.

	oz.	dwt.	gr.		oz.	dwt.	gr.		lb.	oz.	dwt.	gr.
11.	3	17	23	12.	11	13	21	13.	3	10	7	9
	9	12	7		9	2	19		4	3	9	3
	7	7	15		8	17	13		7	7	8	12
	6	3	2		6	15	4		8	9	3	13

14. Subtract 3 oz. 16 dwt. 14 gr. from 6 oz. 13 dwt. 12 gr.

15. Subtract 7 lb. 9 oz. 8 dwt. 20 gr. from 10 lb. 4 oz. 3 dwt. 4 gr.

16. Multiply 3 oz. 5 dwt. 16 gr. by 5, 32, 427.

17. Divide 15 lb. 11 oz. 13 dwt. 8 gr. by 23, and by 9 oz. 11 dwt. 16 gr.

18. Find the weight of 24 gold necklaces each weighing 2 oz. 7 dwt. 12 gr.

19. If 64 gold rings of equal weight are made of 1 lb. of gold, find the weight of each.

20. How many gold rings, each weighing 7 dwt. 12 gr., can be made out of 1 lb. 0 oz. 15 dwt. of gold?

65. English Standard or Avoirdupois Weight.

16 Drams (dr.)	make	1 Ounce (1 oz.).
16 Ounces	...	1 Pound (1 lb.).
28 Pounds	...	1 Quarter (1 qr.).
4 Quarters	...	1 Hundredweight (1 cwt.).
20 Hundredweights	...	1 Ton (1 ton).

A stone (st.) = 14 lb.
A Pound Avoir. = 7000 Grains Troy.

A stone of butcher's meat	=	8 lb.	A cental of corn	= 100 lb.
A sack of coals	=	2 cwt.	A peck of flour	= 14 lb.
A barrel of flour	=	196 lb.	A sack of flour	= 280 lb.
A barrel of gunpowder	=	100 lb.	A pack of wool	= 240 lb.
A pocket of hops	=	168 lb.	A quartern loaf	= 4 lb.

EXAMPLES. 32.

Reduce to drams :

1. 7 tons 13 cwt. 2. 2 tons 2 cwt. 2 qr.

3. 3 tons 9 cwt. 3 qr. 21 lb. 9 oz. 4. 9 tons 7 cwt.

5. 2 tons 3 cwt. 1 qr. 6. 2 cwt. 3 qr. 20 lb. 11 oz. 12 dr.

Reduce to tons, etc. :

7. 999999 dr. 8. 123456 dr. 9. 90000 gr. 10. 1 billion gr.

Addition.

	lb.	oz.	dr.		qr.	lb.	oz.		tons	cwt.	qr.	lb.
11.	7	7	10	12.	13	21	3	13.	1	16	3	19
	9	9	7		7	8	7		2	8	3	0
	12	15	6		8	19	8			12	0	25
	3	12	12		9	2	2		2	4	1	7
	4	4	3		21	3	4		4	7	2	9

14. Subtract 7 lb. 8 oz. 9 dr. from 10 lb. 12 oz. 15 dr.

15. Subtract 2 tons 13 cwt. 3 qr. 12 lb. from 9 tons 2 cwt. 2 qr. 2 lb.

16. Multiply 7 cwt. 3 qr. 12 lb. 9 oz. 2 dr. by 7, 88, 329.

17. Divide 2 tons 10 cwt. 2 qr. 8 lb. 1 oz. by 29, and by 11 lb. 5 oz. 4 dr.

18. Find the weight of 625 iron balls, each weighing 7 lb. 8 oz.

19. The total weight of 56 bales of cotton is 7 tons 1 cwt.; what is the weight of each bale ?

20. How many pick-axes, each weighing 4 lb. 6 oz, can be made from 1 ton 10 cwt. of iron ?

21. Which is heavier, a pound of gold or a pound of feathers ?

22. How many pounds troy are equal to 144 pounds avoir. ?

66. Indian Bazar Weight.

4 Sikis	make	Tola.
5 Sikis	...	Kancha (Powa-chatak).
4 Kanchas or 5 Tolas	...	Chatak (1 ch.).
16 Chataks	...	Seer.
40 Seers		Maund (1 md.).

4 Chataks = 1 Powa. 4 Powas = 1 Seer.
5 Seers = 1 Punshury. 8 Punshuries = 1 Maund.

The weight of a rupee is called a tola. The standard seer = 80 tolas.

A tola = 180 grains Troy. One maund of Bazar weight = 100 lb. Troy = 82$\frac{2}{7}$ lb. Avoir. 35 Seers = 72 lb. Avoir. 1 lb. Avoir. + the weight of a double-pice (200 gr.) = half a seer. 3 Factory maunds = 2 cwt. 49 Bazar maunds = 36 cwt = 54 Factory maunds. 1 cwt. = 1 md. 14 seers 7$\frac{1}{2}$ ch.

EXAMPLES. 33.

Reduce (i) to kanchas, (ii) to tolas :

1. 3 md. 7 seers 3 ch.
2. 2 md. 20 seers 12 ch.
3. 1 md. 34 seers 15 ch.
4. 2 md. 16 seers 2 powas.
5. 35 seers 3 powas.
6. 2 md. 6 punshuries.

Reduce to md., etc. :

7. 4664 kanchas.
8. 3333 kanchas.
9. 39855 tolas.
10. 100000 tolas.

Addition.

11.

md.	seers	ch.
3	8	3
8	12	7
2	29	15
9	36	3
7	7	1

12.

md.	seers	ch.
13	22	7
7	36	13
12	21	8
4	32	9
2	20	2

13.

md.	seers	ch.	kanchas.
3	8	7	1
37	12	8	2
8	29	9	1
29	36	13	3
2	4	10	2

14. Subtract 3 md. 29 seers 7 ch. from 8 md. 17 seers 4 ch.

15. Subtract 2 md. 37 seers 12 ch. 2 kanchas from 10 md. 29 seers 7 ch.

16. Multiply 5 seers 10 ch. 3 kanchas by 9, 42, 2153.

17. Divide 71 md. 11 seers 9 ch. by 73, and by 2 md. 34 seers 1 ch.

18. Find the weight of 273 bags of rice, each bag weighing 2 md. 7 seers 3 ch.

19. If 44 bottles of equal size hold 1 md. 5 seers 6 ch. of ink, how much does one bottle hold ?

20. 657 md. of flour are to be packed into bags holding 1 md. 1 seer 1 ch. each ; how many bags will be required ?

21. How many grains of gold are there in a plate weighing 1 seer 5 ch. ?

22. If 3 chataks of gold be made into 36 equal rings, how many grains will each ring weigh ?

67. Madras Local Weight.

3	Tolas	make	1	Pollum.
8	Pollums	...	1	Seer.
5	Seers or 40 Pollums	...	1	Viss.
8	Viss	...	1	Maund.
20	Maunds	...	1	Candy or Barum.

A Madras maund = 25 lb. Avoir.

EXAMPLES. 34.

Reduce to tolas :

1. 6 pollums 2 tolas. 2. 2 md. 3 viss.
3. 3 md. 7 viss 4 seers. 4. 7 md. 3 seers.
5. 2 candies 7 md. 6. 3 candies 15 md. 5 viss.

Reduce to candies, etc. :

7. 4281 seers. 8. 5182 pollums. 9. 70000 tolas. 10. 92576 tolas.

Addition.

	seers poll. tolas		md. viss seers		can. md. viss poll.
11.	3 . 7 . 2	12.	7 . 5 . 3	13.	7 . 15 . 5 . 9
	1 . 6 . 1		8 . 3 . 2		16 . 7 . 12
	4 . 5 . 2		9 . 6 . 4		21 . 9 . 2 . 23
	2 . 0 . 1		2 . 7 . 1		56 . 3 . 0 . 36

14. Subtract 3 md. 3 viss 3 seers 3 poll. from 7 md. 7 viss 2 seers 1 poll.

15. Subtract 28 can. 17 md. 6 viss 3 seers 2 poll. from 40 can. 12 md.

16. Multiply 3 md. 2 viss 3 seers 2 poll. by 7, 72, 231.

17. Divide 36 can. 17 md. 4 viss by 59, and by 18 md. 3 viss 2 seers 4 poll.

18. Find the weight of 128 bags of rice each weighing 2 md. 3 viss 23 poll.

19. If 320 horses eat 18 can. 9 md. of corn in a certain time, how much does one horse eat ?

20. 9 candies of rice were distributed among a number of beggars, each of whom received 1 viss 2 seers 4 poll. ; how many beggars were there ?

21. How many grains are there in a seer ?

68. Bombay Local Weight.

4 Dhans	make	1 Raktika
8 Raktikas	...	1 Masha.
4 Mashas	...	1 Tank.
72 Tanks	...	1 Seer.
40 Seers	...	1 Maund.
20 Maunds	...	1 Candy.

A Bombay maund = 28 lb. Avoir.

EXAMPLES. [illegible]5.

Reduce to dhans :

1. 10 candies. **2.** 2 md. 7 seers. **3.** 2 md. 2 seers 7 tanks.
4. 3 can. 3 md. **5.** 3 seers 30 tanks. **6.** 3 md. 16 seers 36 tanks.

Reduce to candies, etc. :

7. 60000 tanks. **8.** 78625 tanks. **9.** 7000000 dhans.

10. In one billion dhans, how many candies, md., etc ?

Addition.

	seers	tanks	mashas		md.	seers	tanks		can.	md.	seers	tanks
11.	37	15	1	**12.**	17	15	57	**13.**	1	9	29	25
	29	17	2		7	29	61		2	12	37	35
	7	26	0		15	0	33		3	13	21	56
	9	35	3		5	31	4		4	7	5	64

14. Subtract 3 md. 7 seers 13 tanks from 3 can. 7 md.

15. Subtract 1 can. 13 md. 29 seers 69 tanks from 9 can. 2 md.

16. Multiply 3 md. 15 seers 25 tanks by 5, 36, 231.

17. Divide 7 can. 1 md. 12 seers 56 tanks by 37, and by 14 seers 9 tanks 2 mashas.

18. Find the weight of 312 bags of rice each weighing 1 md. 7 seers 15 tanks.

19. If 144 bullocks eat 7 can. 7 md. 26 seers of hay in a certain time, how much does one bullock eat ?

20. 17 candies of rice are distributed among a number of beggars, giving to each 2 seers 9 tanks ; how many beggars get a share ?

XIV. MEASURES OF LENGTH.

69. **English Linear Measure.**

12	Inches (in.)	make	Foot (1 ft.).
3	Feet		Yard (1 yd.).
$5\frac{1}{2}$	Yards		Pole, Rod or Perch (1 po.).
40	Poles or 220 yards		Furlong (1 fur.).
8	Furlongs or 1760 yards		Mile (1 mi.).
3	Miles		League (1 lea.).

1 Pole	=	5	yd. 1 ft. 6 in.
9 Inches	=	1	Span.
2 Spans or 18 Inches	=	1	Cubit (*Hath*).
∴ 2 Cubits	=	1	Yard.
6 Feet	=	1	Fathom.
4 Poles or 22 Yards	=	1	Chain } Used in land-surveying.
100 Links	=	1	Chain }

The following Table is used by *tailors* :

$2\frac{1}{4}$ Inches	=	1 Nail (*Girrah*).
4 Nails	=	1 Quarter (Span).
4 Quarters	=	1 Yard.
5 Quarters	=	1 Ell.

The following are also used sometimes :

72 points	=	1 inch.
12 lines	=	1 inch.
3 barley-corns	=	1 inch.
3 inches	=	1 palm.
4 inches	=	1 hand (used in measuring horses).
5 feet	=	1 pace.
120 fathoms	=	1 cable's length.
6080 feet	=	1 knot or geographical mile.
60 knots	=	1 degree of latitude.

N. B. In measuring land in Bengal, 4 cubits = 1 cottah ; 20 cottahs = 1 bigha.

70. In reducing poles to yards, we multiply the number of poles by 11, and divide the product by 2. In the converse operation, we multiply the number of yards by 2, and divide the product by 11.

Example 1. Reduce 2 mi. 2 fur. 9 po. 3 yd. 1 ft. to inches.

```
                mi. fur po. yd. ft.
Process :        2 . 2 . 9 . 3 . 1
                 8
                ---
                18 fur.
                40
               729 po.
                11
         2 ) 8019 half-yd.
             4009 yd. + 1 ft. 6 in. rem.   [∵ a half-yd. = 1 ft. 6 in.]
                3 yd.   1 ft.       added
             ----------------
             4012 yd.   2 ft. 6 in.
                3
            12038 ft.
               12
           ------
           144462 in.   Ans.
```

Note. In reducing miles or furlongs to yards, it is convenient to reduce them at once to yards, unless we are prevented by the form of the question, as in the above example. Half-yards may be reduced directly to inches by multiplying the number of half-yards by 18 (∵ a half-yard = 18 inches.)

Example 2. Reduce 201381 inches to miles.

Process :

$$
\begin{array}{r l l}
12\,) & 201381 \text{ in.} & \\
3\,) & 16781 \text{ ft.} & +9 \text{ in.} \\
 & 5593 \text{ yd.} & +2 \text{ ft.} \\
 & 2 & \\
11\,) & 11186 \text{ half-yd.} & \\
40\,) & 1016 \text{ po.} & +10 \text{ half-yd.} \\
8\,) & 25 \text{ fur.} & +16 \text{ po.} \\
 & 3 \text{ mi.} & +1 \text{ fur.}
\end{array}
$$

∴ 201381 in. = 3 mi. 1 fur. 16 po. 10 half-yd. 2 ft. 9 in.
= 3 mi. 1 fur. 16 po. 5 yd. 2 ft. 9 in.
= 3 mi. 1 fur. 17 po. 1 ft. 3 in.

[∵ 5 yd. 1 ft. 6 in. = 1 po.]

If in a result the yd., ft. and inches exceed 5 yd. 1 ft. 6 in., we must substitute 1 po. for this.

EXAMPLES. 36.

Reduce to inches :

1. 125 yd. **2.** 5 fur. **3.** 3 mi. **4.** 2 lea.

5. 2 mi. 7 fur. 2 po. **6.** 3 mi. 2 fur. 20 po.

7. 3 lea. 5 fur. 11 po. **8.** 3 po. 4 yd. 2 ft.

9. 5 po. 3 yd. 1 ft. **10.** 7 po. 2 yd. 9 in.

11. 2 mi. 7 fur. 13 po. 4 yd. **12.** 2 lea. 6 fur. 20 po. 3 yd. 1 ft. 6 in.

Reduce to miles, furlongs, poles, etc. :

13. 156 yd. **14.** 202 yd. **15.** 107 yd. **16.** 196 yd.

17. 1234 in. **18.** 5890 ft. **19.** 73212 in. **20.** 80021 in.

21. 1000 in. **22.** 10000 ft. **23.** 234567 in. **24.** 987654 in.

Reduce

25. 7 fathoms to inches. **26.** 3 cubits 1 span to inches.

27. 3 yd. 1 cubit to inches. **28.** 5 ells to nails.

29. 2 ells 1 qr. to nails. **30.** 1000 nails to ells.

31. How many links are there in a mile?

XV. MEASURES OF AREA.

71. A square inch is a square whose side is an inch in length.

English Square Measure.

144 Square Inches (sq. in.) make	1	Square Foot (1 sq. ft.).
9 Square Feet ...	1	Square Yard (1 sq. yd.).
$30\frac{1}{4}$ Square Yards ...	1	Square Pole, Rod or Perch. [(1 sq. po.).
40 Square Poles ...	1	Rood (1 ro.).
4 Roods or 4840 sq yards ...	1	Acre (1 ac.).
640 Acres ...	1	Square Mile (1 sq mi.).

A square chain $= 22 \times 22$ sq. yards or 484 sq. yards.
∴ 10 sq. chains = 1 acre.
1 sq pole = 30 sq. yd. 2 ft. 36 in.

72. In reducing sq. poles to sq. yards, we multiply the number of sq. poles by 121, and divide the product by 4. In the converse operation, we multiply the number of sq. yards by 4, and divide the product by 121.

Example 1. Reduce 2 ac. 1 ro. 13 sq. po. 12 sq. yd. 7 sq. ft. to sq. inches.

```
              ac. ro. po. yd. ft.
Process :      2 . 1 . 13 . 12 . 7
               4
               9 ro.
              40
             373 sq. po.
              11
            4103
              11
       4) 45133 quarter sq. yd.
          11283 sq. yd. + 2 sq. ft. 36 sq. in. [∵ a qr. sq. yd. = 2 sq. ft. 36 sq. in.]
             12 sq. yd.   7 sq. ft.             added
          11295 sq. yd.   9 sq. ft. 36 sq. in.
                9
         101664 sq. ft.
             12
        1219968
             12
       14639652 sq. in.   Ans.
```

[The learner should note that, 1 qr. sq. yd. = 2 sq. ft. 36 sq. in.; 2 qr. sq. yd. = 4 sq. ft. 72 sq. in.; and 3 qr. sq. yd. = 6 sq. ft. 108 sq. in.]

Note. In reducing acres or roods to sq. yards, it is convenient to reduce them at once to sq. yards, unless we are prevented by the form of the question. Quarter sq. yards may be reduced directly to sq. inches by multiplying the number of quarter sq. yards by 18×18 ($\because$ a quarter sq. yd. = a sq. cubit = 18×18 sq. in.).

Example 2. Reduce 8753067 sq. inches to acres.

Process :

144 { 12) 8753067 sq. in.
  12) 729422...3 }
  9) 60785...2 } 27 sq. in.
  6753 sq. yd + 8 sq. ft.
  4

121 { 11) 27012 quarter sq. yd.
  11) 2455...7 }
  40) 223...2 } 29 qr. sq yd.
  4) 5 ro. + 23 sq. po.
  1 ac + 1 ro.

$\therefore$ The result = 1 ac. 1 ro. 23 po. 29 qr. yd. 8 ft. 27 in.
= 1 ac. 1 ro. 23 po. 7 yd. 1 qr. yd. 8 ft. 27 in.
= 1 ac. 1 ro. 23 po 7 yd. 10 ft. 63 in.
= 1 ac. 1 ro. 23 po. 8 yd. 1 ft. 63 in.

If in a result the sq. yd., ft. and inches exceed 30 sq. yd. 2 ft. 36 in. we must substitute 1 sq. po for this.

EXAMPLES. 37.

Reduce to sq. inches :

1. 23 sq. yd. **2.** 3 roods. **3.** 120 ac. **4.** 2 sq miles.
5. 7 ac. 2 ro. 8 po. **6.** 12 ac. 3 ro. 20 po. **7.** 1 ac. 1 ro. 1 po.
8. 3 sq. po. 7 yd. 7 ft. **9.** 5 sq. po. 3 yd. 2 ft.
10. 7 sq. po. 20 yd. 36 in. **11.** 2 ac. 3 ro. 7 po. 17 yd.
12. 3 ac. 2 ro. 17 po. 9 yd. 2 ft. 72 in.

Reduce to acres, roods, sq. poles, etc. :

13. 365 sq. yd. **14.** 740 sq. yd. **15.** 971 sq. yd.
16. 1000 sq. yd. **17.** 7824 sq. yd. **18.** 37821 sq. yd.
19. 93456 sq. ft. **20.** 87893 sq. ft. **21.** 7234 sq. in.
22. 78934 sq. in. **23.** 987650 sq. in. **24.** 9876543 sq. in.

Reduce

25. 7 sq. chains to sq. inches.
26. One million sq. links to sq. yards.

73. Land Measure of Bengal.

1 Square Cubit	makes	1 Ganda (1 ga.).
20 Gandas	make	1 Chatak (1 ch.).
16 Chataks	...	1 Cottah (1 cot.).
20 Cottahs	...	1 Bigha (1 bi.).

1 bigha = 1600 sq. yards.
121 bighas = 40 acres.
1936 bighas = 1 sq. mile.

EXAMPLES. 38.

Reduce to gandas :

1. 3 bi. 12 cot. 12 ch.
2. 12 cot. 9 ch. 5 ga.
3. 6 bi. 11 cot. 11 ch.
4. 19 bi. 7 cot. 8 ch.
5. 19 cot. 15 ch. 19 ga.
6. 15 bi. 15 cot. 15 ch.

Reduce to bighas, etc. :

7. 431 ch.
8. 728 ga.
9. 7892 ga.
10. 10000 ga.

74. Land Measure of North-Western Provinces.

20 Kachwansi	make	1 Biswansi.
20 Biswansi	...	1 Biswa.
20 Biswas	...	1 Bigha.

1 guj ilahi = 33 inches. 60 guj ilahi = 55 yards.
1 bigha = (60 × 60) sq. guj ilahi = (55 × 55) sq. yards.
= 3025 sq. yards.

74a. Land Measure of the Punjab.

9 Square Karam or 9 Sarsai	make	1 Marla.
20 Marlas	...	1 Kanal.
4 Kanals	...	1 Bigha.
2 Bighas	...	1 Ghuma.

1 karam = 3 cubits. 1 bigha = 1620 sq. yards.

75. Land Measure of Madras.

144 Square Inches	make	1 Square foot.
2400 Square feet	...	1 Ground or Manai.
24 Grounds	...	1 Cawny.
484 Cawnies	...	1 Square Mile.

121 cawnies = 160 acres.

76. Land Measure of Bombay.

29¼ Square Cubits	make	1	Kathi.
20 Kathis	...	1	Pand.
20 Pands	...	1	Bigha.
6 Bighas	...	1	Rukeh.
20 Rukehs	...	1	Chahur

XVI. MEASURES OF SOLIDITY AND CAPACITY.

77. A **cube** is a solid figure contained by six equal squares. A **cubic inch** is a cube whose edge is an inch in length.

Measures of Solidity. (*English.*)

1728 Cubic Inches	make	1 Cubic Foot (1 cu. ft.).
27 Cubic Feet	...	1 Cubic Yard (1 cu. yd.).

A ton of shipping = 42 cubic feet.

EXAMPLES. 39.

1. Reduce 3, 7, 12, 16, 20, 39 cu. yd. to cu. in.
2. Reduce 123456, 987654 cu. in. to cu. yd.

78. Measures of Capacity. (*English.*)

	4 Gills	make	1 Pint (1 pt.).	
	2 Pints	...	1 Quart (1 qt.).	
	4 Quarts	...	1 Gallon (1 gall.).	
	2 Gallons	...	1 Peck (1 pk.).	For *dry* goods only.
	4 Pecks	...	1 Bushel (1 bus.).	For *dry* goods only.
	8 Bushels	...	1 Quarter (1 qr.).	For *dry* goods only.
	5 Quarters	...	1 Load (1 ld.).	For *dry* goods only.
	2 Loads	...	1 Last (1 last).	For *dry* goods only.
Also	2 quarts	=	1 pottle (1 pot.).	For *dry* goods only.
	2 bushels	=	1 strike (1 str.).	For *dry* goods only.
	4 bushels	=	1 coomb (1 coomb).	For *dry* goods only.

A *Barrel* contains 36 gallons.

A half barrel (18 gallons) is called a *kilderkin*, and a quarter barrel (9 gallons) a *firkin*.

A *hogshead* (hhd.) of ale contains 1½ barrels or 54 gallons; a *butt* of ale 3 barrels and a *pipe* 6 barrels.

The terms *hogshead*, *butt* and *pipe* are also used in measuring wine, but they are different for different kinds of wine.

Note. A gallon of distilled water weighs exactly 10 lb. Avoir. **A pint of water weighs a pound and a quarter.** [A gallon contains 277·274 cubic inches.] A cubic foot of water weighs *about* 1000 oz. Avoir.

EXAMPLES. 40.

Reduce to gills:

1. 12 gall. 2 qt. 1 pt. **2.** 2 barrels 16 gall. **3.** 1 barrel 11 gall.
4. 6 bus. 2 pk. 1 gall. **5.** 4 qr. 4 bus. 2 pk. **6.** 1 ld. 3 qr. 7 bus.
7. 7 lasts 1 ld. 3 qr. **8.** 2 lasts 4 qr. 5 bus. **9.** 20 lasts 1 ld. 4 qr.

Reduce to barrels, gallons, etc.:

10. 1000 gills. **11.** 2073 gills. **12.** 3400 gills. **13.** 7225 gills.

Reduce to lasts, loads, quarters, etc.:

14. 3000 gills. **15.** 1500 gills. **16.** 25000 gills. **17.** 98765 gills.

18. What is the weight of 2 gall. 2 qt. of water?

19. Give in pounds Avoir. the weight of 2 cu. yd. 2 cu. ft. of water.

20. How many pottles are there in a coomb? How many in a strike?

XVII. MEASURES OF TIME, ANGLES, NUMBER, AND APOTHECARIES' WEIGHT.

79. Measures of Time. (*English.*)

60	Seconds (sec.) make	1	minute (1 min.).
60	Minutes ...	1	Hour (1 hr.).
24	Hours	1	Day (1 da.).
7	Days	1	Week (1 wk.).
365	Days	1	Year (1 yr.).
366	Days	1	Leap-year.
100	Years	1	Century.

Note 1. Each day is considered to commence at midnight.

Note 2. In rough calculations a month is taken to consist of 30 days. But the 12 months, called **Calendar Months,** into which the year is divided, are of variable length.

February has 28 days (and in Leap-year 29).

Thirty days have September,
April, June and November.

The other months have 31 days each.

Note 3. If the number of a particular year is divisible by 4 it is a Leap-year; but centuries not divisible by 400 are not Leap-years. Thus 1888, 1732, 1600 are Leap-years; 1887, 1739, 1800 are common years.

[The solar year consists of 365·242218 mean solar days (or 365 da. 5 hr. 48 min. 48 sec. very nearly) or nearly $365\frac{1}{4}$ days; hence to make the civil year correspond with the solar, we take 3 consecutive years of 365 days and a fourth, called *leap-year*, of 366 days, those being leap-years of which the numbers are divisible by 4. But in this way we insert 100 days in 400 years, which is too much, for $\cdot 242218 \times 400$ is 96·8872 or 97 days nearly; to make the necessary correction centuries not divisible by 400 are taken as common years.]

Note 4. The year contains 52 weeks and 1 day ($\because 52 \times 7 + 1 = 365$), but in calculating the income of men paid by the week, it is customary to consider the year to consist of 52 weeks.

EXAMPLES. 41.

Reduce to seconds:

1. 7 hr. 12 min. 3 sec. **2.** 7 da. 9 hr. 10 min. **3.** 2 wk. 3 da. 12 hr.

Reduce to weeks, days, hours, etc.:

4. 5000 sec. **5.** 98765 sec. **6.** One lac sec. **7.** One million sec.

Find the number of days (including one only of the two days named) from

8. 3rd Jan. to 7th April 1887. **9.** 20th Jan. to 20th May 1888.

10. May 10th '87 to Jan. 9th '88. **11.** Aug. 1st '80 to March 1st '82.

12. 21st Feb. to 7th Dec. 1700. **13.** 30th Dec. '83 to 30th March '86.

14. The 1st January 1880 was on Monday; what day of the week was June 20th of the same year?

15. The 9th of December 1845 was on Sunday; what day of the week was 1st January 1847?

80. Measures of Angles.

60 Seconds (60″)	make	1	Minute (1′).
60 Minutes	...	1	Degree (1°).
90 Degrees	...	1	Right Angle (1 rt. gle.).

EXAMPLES. 42.

Reduce to seconds:

1. 7°. 17′. 27″. **2.** 240°. 25′. 35″. **3.** 4 rt. gle.

Reduce to right angles, degrees, etc.:

4. 4000″. **5.** 37056″. **6.** 7000′. **7.** 8256′. **8.** 987654″.

81. Measures of Number.

	12 Units	make	1 Dozen.
	12 Dozen	...	1 Gross.
	12 Gross	...	1 Great Gross.
	20 Units	...	1 Score (*Kurri*).
Also	24 Sheets of paper	...	1 Quire.
	20 Quires	...	1 Ream.
	10 Reams	...	1 Bale

EXAMPLES. 43.

1. In 50 reams of paper, how many sheets?

2. How many reams, quires, etc. are there in fifty thousand sheets of paper?

3. How many scores are there in 5 great gross?

82. Apothecaries' Weight.

(i) *Measures of Weight.*

Druggists use the *grain* to weigh small quantities and the *pound* and *ounce* Avoir. to weigh large quantities. Some physicians in prescribing use the following table:

20 Grains	make	1 Scruple (1 scr.).
3 Scruples	...	1 Drachm (1 dr.).
8 Drachms	...	1 Ounce Troy.

(ii) *Measures of Capacity.*

60 Minims (m.) or drops	make	1 Fluid drachm (fl. dr.).
8 Fluid drachms	...	1 Fluid ounce (fl. oz.).
20 Fluid ounces	...	1 Pint (O.).
8 Pints	...	1 Gallon (C.).
A teaspoonful	=	1 Fluid drachm.
A dessertspoonful	=	$2\frac{1}{2}$ Fluid drachms.
A tablespoonful	=	4 Fluid drachms.

Note. Since a pint of water weighs a pound and a quarter, the weight of a fluid ounce of distilled water is an *ounce* Avoir.

EXAMPLES. 44

Reduce

1. 2 oz. 2 dr. 2 scr. to grains. 2. 3 oz. 3 dr. 12 gr. to grain.

3. 2 O. 12 fl. oz. to minims. 4. 2 C. 4 O. to minims.

5. 7 C. 7 O. 15 fl. oz. 5 fl. dr. 9 m. to minims.

MISCELLANEOUS EXAMPLES. 45.

1. A girl can paper 2 pins in a second; how many pins can she paper in a working day of 8 hours 30 minutes?

2. Find the price of 3 md. 7 seers of milk at 2*a.* 6*p.* per seer.

3. Find the value of 12 lb. 7 oz. of gold at £3. 15*s.* $4\frac{1}{2}$*d.* per oz.

4. A train travels 19 mi. 7 fur. 30 po. per hour; how far will it travel in 24 hours?

5. A fruit seller sold 210 oranges at 1 pice each, 76 apples at 1 anna each, and 55 mangoes at 1*a.* 6*p.* each; how much did he realise from the sale?

6. How many cwt. of coal will supply 64 fires for 3 weeks, each fire consuming 1 cwt. 2 qr. 1 lb. per day?

7. If the cost of 9 md be R480, what is the cost of a chatak?

8. If the cost of a ton be £203, what is the cost of a pound?

9. How many shot, each weighing 2 oz. 3 dr., will make up a heap weighing one ton?

10. How many parcels, each weighing 1 md. 10 seers, can be made up of goods weighing 132 md., and what weight will remain over?

11. How many jars, each containing 2 gall. 3 qt. 1 pt. 3 gills, can be filled out of a cask containing 285 gallons?

12. How many pieces of rope, each 2 ft. 9 in. long, can be cut off a length of 1760 yards, and what length will remain over?

13. A train travels 45 miles in 2 hours; how many yards does it travel in a second?

14. A man gave R7. 9*a.* 6*p.* to each of 24 men, and then had R6. 7*a.* 9*p.* left; how much had he at first?

15. *A* has R3. 7*a.* 9*p.* more than *B*, *B* has R2. 8*a.* 3*p.* less than *C*, and *C* has R12; how much has *A*?

16. If a man's net annual income be R17856. 4*a*, how much may he spend per day and per week to the nearest pie, so as not to run into debt? [Reckon 52 weeks and 365 days to the year.]

17. If the daily income of a man be R3. 4*a.* 9*p.*, how much can he spend per day that he may save R239. 8*a.* 6*p.* in a year?

18. If a man spends R5. 3*a.* 3*p.* daily, how much will he be able to save out of an annual income of R2400?

19. How much to the nearest farthing can a person spend daily if he wishes to save £300 out of an annual income of £700?

20. A gentleman's gross annual income is R3000; he pays R72. 3*a.* annually in taxes: what must his daily expenses be that he may save R1080 in a year?

21. A man spends R7. 8*a*. 9*p*. daily, and saves R1000 a year: what is his annual income?

22. A clerk received £114. 7. 6 as pay in 1888: how much is that per day?

23. A man was born on the 10th of January 1832; what was his age on the 17th of April 1888?

24. I distribute R300 among boys, giving a rupee, a half-rupee, a quarter-rupee and a two-anna piece to each; how many boys get a share?

25. Sound travels 1125 ft. in a second; if a gun is fired at a distance of 1875 yards, what time must elapse between the seeing of the flash and the hearing of the report?

26 How many steps does a soldier whose stride is 2 ft. 8 in. take in walking 2 miles?

27 If a soldier takes 3240 strides in walking 1 mile 1030 yards, what is the length of his stride?

28. The circumference of a bicycle wheel is 12 ft. 7 in.; how many complete revolutions does it make in going 10 miles?

29. A certain sum of money was divided into 18 equal parts; each part was R4. 8*a*. 3*p*. and there was R2. 7*a*. 6*p*. over; find the sum.

30. A man earned R35. 9*a*. 6*p*. in January and R49. 8*a*. 9*p*. in February; he spent R26. 3*a*. 3*p*. each month: how much did he save in the two months?

31. A man earns £1. 7*s*. 6*d*. per week, and pays 7*s*. 6*d*. every fourth week to his club; what is his net income in a year of 52 weeks?

32. How many complete yards are there in the united length of 7 benches, each 7 ft. 7 in. long?

33. A man spends in 4 months as much as he earns in 3 months; what does he save out of an annual income of R2750. 8*a*.?

34. *A* and *B* together have £56. 12*s*. 6*d*.; *A* has £3. 17*s*. 9*d*. more than *B*; how much has *A*?

35. The earnings of a man and his 2 sons amount to £600 a year, and their expenses to £400; if the balance be divided equally, how much will each receive?

36. How many quart bottles can be filled out of a cask containing 2 cwt. 1 qr. 8 lb. of water?

37. The 1st of January 1881 was on Monday; find the number of Mondays in that year.

38. A vessel which holds 10 gallons weighs when empty 30 lb.; what is the weight of the vessel when full of water?

39. Your father was 25 yr. 7 mo. 10 da. old when you were born : your sister was born when your father was 21 yr. 9 mo. 8 da. old : how old is your sister now if your age is 12 yr. 6 mo. ?

40. Four dollars, 3 half-guineas, 5 half-crowns and 6 florins amount to £3. 12*s*. 8*d*. ; what is the value of a dollar ?

41. Two pieces of cloth of equal length cost £3 . 0 . 9 and £2 . 5 . 0 respectively ; the price of the first was 3*s*. 4½*d*. per yd. : what was the price of the second per yard ?

42. A merchant bought 350 lb. Avoir. of lead, and sold it by Troy weight ; how many pounds Avoir. did he gain ?

43. A shop-keeper's weight was deficient 3 tolas to a seer ; what quantity would he defraud his customers in selling 8 maunds ?

44. Fifty bags of rice are bought for R800. 12*a*, 6*p*. at R3. 3*a*. 3*p*. per maund ; what is the weight of each bag ?

45. Light travels 186500 miles in a second ; what time does it take in travelling from the sun to the earth, a distance of 92877000 miles ?

46. The small wheel of a tricycle makes 330 revolutions more than the large wheel in passing over a mile ; if the circumference of the large wheel be 8 ft, what is the circumference of the other ?

47. A weekly newspaper was numbered 4 on the 7th January 1885 ; when was it numbered 40 ?

48. A daily newspaper which is published on week days only was numbered 20 on Monday the 13th January 1884 ; on what date was it numbered 120 ?

49. A person travelled 120 miles by railway at 15 miles an hour, 120 miles by road at 8 miles an hour, and 60 miles by bullock cart at 2 miles an hour : how long did he take ?

50. The distance of the sun from the earth is 91776000 miles, and light travels from the former to the latter in 7 min. 58 sec. ; find the velocity of light per second.

51. The value of a mark being 13*s*. 4*d*., and that of a dollar 4*s*. 2*d*., how many half-crowns are there in 9 marks + 12 dollars ?

52. A person laid out £43. 9*s*. 4*d*. in spirits at 5*s*. 4*d*. a gallon, some of which leaked out in the carriage ; he sold the remainder for £54, at the rate of 7*s*. 6*d*. a gallon : how many gallons leaked out ?

53. A wheel makes 600 revolutions in passing over 1 mile 40 yards ; what is its circumference ?

54. Divide R65. 10*a*. equally among 8 men, 12 women and 30 children ; supposing the children to have received their shares,

and the men to have given up their shares to the women, how much would each woman receive?

55. How many times will a church-clock, which chimes the quarters, strike and chime in February 1900?

56. How many times does the 29th day of the month occur in 400 consecutive years?

57. The circumferences of the large and small wheels of a tricycle are 13 ft. 9 in. and 3 ft. 4 in. respectively; how many more turns will the latter have made than the former when the tricycle has gone a distance of 15 miles?

58. If for every R1 rent paid to his landlord a man pays in addition 1 anna for gas, how much will he have left out of an annual income of R3000 if he lives in a house whose monthly rent is R20?

59. After measuring 40 yards of a rope it was discovered that the measuring yard was an inch too long; what was the true length measured?

60. One man is 30 years 17 weeks and 5 days old, and another is 26 years 9 weeks and 3 days old; a third is just as much younger than the first as he is older than the second: what is the age of the third?

XVIII. BARTER, GAIN AND LOSS, ETC.

83. Barter.—*Example.* How many seers of sugar at 4*a*. 6*p*. a seer must a grocer give in exchange for 9 lb. of tea at R1. 2*a*. a lb.?

Cost of 9 lb. of tea = R1. 2*a* × 9 = R10. 2*a*.

∴ The number of seers of sugar rqd. = R10. 2*a*. ÷ 4*a*. 6*p*. = 36.

EXAMPLES. 46.

1. How many pounds of tea at R1. 4*a*. a pound must be given in exchange for 40 yards of silk at R2. 10*a*. a yard?

2. How many dollars of 4*s*. 2*d*. each can be obtained for 100 rupees of 1*s*. 10*d*. each?

3. [illegible] be given in exchange for [illegible] maunds of brown-sugar at 3 an[illegible] what is the price of the ribbon per yard?

4. A man exchanges 45 sheep at £2. 5. 9 each and 37 pigs at £3. 13. 6 each for 13 oxen at £17 6. 6 each, the difference being paid or received in money; how much does he pay or receive?

5. Seven pounds of tea at R1. 3. 6 a pound and [illegible] pounds of [illegible] are given in exchange for 15 maunds of wheat at [illegible]1. 13. 3 [illegible] and; find the price of a pound of coffee.

84. Gain and loss.—*Example.* If 25 yards of cloth are bought at 7*s.* 6*d.* a yard and sold at 8*s.* 9*d.* a yard, how much is gained?

Profit on each yard = 8*s.* 9*d.* − 7*s.* 6*d.* = 1*s.* 3*d.*

∴ Total profit = 1*s.* 3*d.* × 25 = £1. 11*s.* 3*d.*

EXAMPLES 47.

1. A man gives 15 maunds of rice worth R3. 8*a.* a maund, and receives in exchange 22 maunds of flour worth R2. 8*a.* a maund; does he gain or lose, and by how much?

2. A man buys 150 yards of cloth at R1. 1*a.* 3*p.* per yard, and sells at R1. 3*a.* 6*p.* per yard; what does he gain altogether?

3. A grocer bought a chest of tea containing 320 lb. for R405, and sold it at R1. 5*a.* 9*p.* per lb.; what did he gain?

4. Twenty-nine sheep are bought at R5. 8*a.* each; 15 of them are sold at R6. 4*a.* each, and the rest at R5. 4*a.* each; find the gain.

5. A grocer buys 15 maunds of sugar at 4*a.* 6*p.* a seer, and sells at R13. 4*a.* 6*p.* a maund; what is his gain?

6. Out of 2 md. 15 seers of milk, bought for R6. 9*a.* 9*p.*, 7 seers are lost by leakage; what is gained by selling the remainder at 1*a.* 6*p.* a seer?

7. A cwt. of sugar is bought for R14. 9*a.* 6*p.*, and is sold for R16. 5*a.* 6*p.*; what is the gain per lb.?

8. A grocer bought 1 cwt. 1 qr. of sugar for £1. 15*s.*, and gained 11*s.* 8*d.* by retailing it; at what rate per lb. was it sold?

9. A merchant bought 40 gallons of wine, and lost £5 by selling it for £37; at what rate per gallon did he buy it?

10. A dealer bought wheat at 38*s.* 9*d.* per qr.; he subsequently sold it at £2. 0*s.* 3*d.* per qr., and made a profit of £1. 16*s.* altogether; how many quarters did he buy and sell?

11. A man buys 45 yards of silk at 6*s.* 6*d.* per yard, 15 yards of which being damaged, he sells at 5*s.* per yard; at what price must he sell the rest so as to gain £1. 12. 6 altogether?

12. A grocer buys 200 lb. of tea at R1. 2*a.* per lb., and sells one-half of it at R1. 3*a.* per lb.; at what rate must he sell the remainder so as to gain R25 on the whole?

13. If 7*s.* 6*d.* be lost by selling an article for £3, what would have been gained or lost by selling it for £4?

14. I sold some goods weighing 13 cwt. 2 qr. 9 lb., for £72. 17. 7½, gaining thereby 3½*d.* per lb. How much should I have gained per lb. if I had sold them at £5. 12. 0 per cwt.?

15. A tradesman buys a piece of cloth 50 yards in length for R40. 10*a*. ; at what price per yard must he sell it (i) that he may gain 5*a*. per yard, (ii) that he may gain R18. 12*a*. on the whole?

85. Mixtures.—*Example* 1. If 3 maunds of rice at R2. 8*a*. per maund be mixed with 5 maunds at R3. 2*a*. per maund, find the price of the mixture.

	Cost of 3 md. at R2. 8*a*.	=	R2. 8*a*. × 3 = R7. 8*a*. ;
	cost of 5 md. at R3. 2*a*.	=	R3. 2*a*. × 5 = R15. 10*a*.
∴	cost of 8 md. of mixture	=	R7. 8*a*. + R15. 10*a*.
		=	R23. 2*a*
∴	Cost of 1 md. of mixture	=	R23. 2*a*. ÷ 8.
		=	R2. 14*a*. 3*p*.
∴	Price required	=	R2. 14*a*. 3*p*. per maund.

Example 2. How much water must be added to 12 gallons of beer at 10*s*. a gallon, to reduce the price to 8*s*. a gallon?

The price of the whole mixture at 8*s*. a gallon must be equal to the price of 12 gallons of beer at 10*s*. a gallon. Therefore, if we divide the price of 12 gallons of beer at 10*s*. a gallon by 8*s*. we shall get the number of gallons in the mixture.

Price of 12 gallons of beer = 10*s*. × 12 = 120*s*. ;
∴ number of gallons in the mixture = 120*s*. ÷ 8*s*. = 15 ;
∴ number of gallons of water added = 15 − 12 = 3.

EXAMPLES. 48.

1. A mixture is made of 7 seers of sugar at 4*a*. 6*p*. per seer, 2 seers at 4*a*. per seer and 3 seers at 3*a*. 6*p*. ; find the value per seer of the mixture.

2. A man bought 3 qr. of wheat at 30*s*. per qr. and 9 qr. at 26*s*. per qr. ; he mixed them, and sold the mixture at 3*s*. 7½*d*. per bushel ; how much did he gain?

3. To 20 seers of milk, bought at 1*a*. 9*p*. a seer, 5 seers of water are added, and the mixture is sold at 2*a*. per seer ; how much is gained?

4. A merchant buys 15 md. of sugar at R9. 8*a*. per md., 18 md. at R9. 4*a*. per md. and 10 md. at R9 per md., and pays R4. 2*a*. for carriage ; he mixes them : at what price per md. must he sell the mixed sugar so as not to lose by the sale?

5. 10 lb. of coffee are mixed with 2 lb. of chicory ; if the mixture be worth 1*s*. 11*d*. per lb., and the chicory 3*d*. per lb., what is the value per lb. of the pure coffee?

6. A grocer mixes 36 lb. of tea at 2*s* 4½*d* per lb. with 48 lb.

at 1*s*. 10½*d*. per lb. ; at what price per lb. must he sell the mixture so as to gain 13*s*. 6*d*. on his outlay ?

7. A woman buys 8 dozen eggs at 2½*d*. per dozen, and 12 dozen more at 1¼*d*. per dozen ; at what price per dozen must she sell the whole so as to gain ¼*d*. per dozen ?

8. How much water must be mixed with 36 seers of milk at 1*a*. 9*p*. per seer, so as to reduce the price to 1*a*. 6*p*. per seer ?

9. How many pounds of tea dust (worth nothing) must a grocer mix with 20 lb. of tea at 2*s*. 6*d*. per lb., to enable him to sell the mixture at 2*s*. per lb. and gain at the same time 8*s*. on the transaction ?

10. A grocer buys 30 lb. of tea at 2*s*. a pound and 50 lb. of tea at 2*s*. 8*d*. a pound, and having mixed them sells 40 lb. of the mixture at 2*s*. 4*d*. ; at what price per lb. must he sell the remainder that he may neither gain nor lose ?

86. Division of Money—*Example* 1. Divide R13. 9*a*. among *A*, *B* and *C* so that *A* may have 12*a*. 3*p*. more than *B*, and *B* R1. 2*a*. 9*p*. more than *C*.

B is to have R1. 2*a*. 9*p*. more than *C*, and *A* is to have 12*a*. 3*p*. +R1. 2*a*. 9*p*. more than *C* ; if we take away these sums to be subsequently given to *B* and *A* respectively, the remaining portions of their share will be each equal to the share of *C*.

$$\begin{array}{rrr} R. & a. & p. \\ 1\ . & 2\ . & 9 \\ & 12\ . & 3 \\ 1\ . & 2\ . & 9 \\ \hline R3\ . & 1\ . & 9 \end{array} \qquad \begin{array}{rrrrl} & R. & a. & p. & \\ & 13\ . & 9\ . & 0 & \\ & 3\ . & 1\ . & 9 & \\ \hline 3\,) & 10\ . & 7\ . & 3 & \\ \hline & 3\ . & 7\ . & 9 & = C\text{'s share.} \\ \therefore & 4\ . & 10\ . & 0 & = B\text{'s share.} \\ \text{and} & 5\ . & 6\ . & 9 & = A\text{'s share.} \end{array}$$

EXAMPLES. 49.

1. Divide R39. 7*a*. 9*p*. between *A* and *B*, so that *A* may get R7. 4*a*. 3*p*. more than *B*.

2. Divide £28. 7*s*. 6*d*. between *A* and *B*, so that *A* may receive £3. 14*s*. 3*d*. less than *B*.

3. Divide R357. 14*a*. 6*p*. among 15 men, giving R11. 14*a*. 9*p*. more to each of two of them than to each of the others.

4. Divide R679 among 27 men and 5 women, so that a man may get R6 less than a woman.

5. Divide R39. 4*a*. 6*p*. among *A*, *B* and *C*, so that *A* may receive R3 more than *B*, and *B* R4 more than *C*.

6. Divide R329. 7*a*. 9*p*. among *A*, *B* and *C*, so that *A* may get R7 more than *B*, and *B* R2 less than *C*.

7. £95. 10*s*. is divided among 8 men, 7 women and 6 boys, so that each man receives 10*s*. more than each woman, and each woman 10*s*. more than each boy; find how much the men receive.

Example 2. Divide R59. 6*a*. among 3 men, 5 women and 6 boys, so that each man may receive three times as much, and each woman twice as much, as a boy.

3 men = 9 boys
5 women = 10 ...
6 boys = 6 ...

		Rs.		a.	
25	5)	59	.	6	
	5)	11	.	14	
		2	.	6	= each boy's share
	∴	4	.	12	= ... woman's ..
	and	7	.	2	= ... man's ..

EXAMPLES. 50.

1. Divide R15. 9*a*. 6*p*. between a boy and a girl, so that the boy may receive twice as much as the girl.

2. Divide R31. 3*a*. between *A*, *B* and *C* in such a manner that *A*'s share may be 3 times, and *B*'s twice, *C*'s.

3. Divide R100 among 3 men, 5 women and 10 boys, so that each man may receive 4 times as much as a boy, and each woman twice as much as a boy.

4. Divide £11. 15. $4\frac{1}{2}$ among *A*, *B* and *C*, so that *A* may receive twice as much as *B*, and *B* twice as much as *C*.

5. Divide £10. 7. 6 among 3 persons, so that one may receive twice as much as each of the others.

6. Divide R39. 7*a*. 9*p*. between *A* and *B*, so that *A* may receive R1. 14*a*. 3*p*. more than twice the amount to be received by *B*.

Example 3. Divide R28. into an equal number of rupees, half-rupees and quarter-rupees.

A rupee + a half-rupee + a qr.-rupee = R1 + 8*a*. + 4*a*. = R1. 12*a*.

∴ The number of each kind of coin = R28 ÷ R1. 12*a*. = 16.

EXAMPLES. 51.

1. Divide R22. 8*a*. into an equal number of rupees, half-rupees, quarter-rupees and two-anna pieces.

2. Divide £17 into an equal number of sovereigns, half-sovereigns, half-crowns, shillings and sixpences.

3. A box contains an equal number of crowns, shillings and pennies; the total amount in the box is £3. 13s.: find the number of each.

4. R100 is divided among an equal number of men, women and boys; each man receives R2 8a., each woman R2 and each boy R1. 12a.: find the number of men, women or boys.

5. A bag contains a certain number of rupees, twice as many half-rupees, and 4 times as many quarter-rupees; the whole sum amounts to R33: find the number of each.

6. Among how many children may R60 be divided so that each child may receive a rupee, an eight-anna piece, a four-anna piece and a two anna piece?

87. *Example.* A and B together have R13. 8a., B and C together have R8. 8a., A and C together have R11. 8a.; how much has A?

R13. 8a. + R11. 8a. = twice A's money + B's money + C's money;
but R8 8a. = B's money + C's money.
∴ (R13. 8a. + R11. 8a. − R8. 8a.) or R16. 8a. = twice A's money.
∴ A's money = R16. 8a. ÷ 2 = R8. 4a.

Or thus:

(R13. 8a. + R8. 8a. + R11. 8a.) or R33. 8a. = twice A's money + twice B's money + twice C's money;
∴ (R33. 8a. ÷ 2) or R16. 12a. = A's money + B's money + C's money;
but R8. 8a = B's money + C's money;
∴ A's money = R16. 12a − R8. 8a. = R8. 4a.

EXAMPLES 32.

1. A and B together have R6. 0a. 3p., B and C together have R4. 15a. 9p., A and C together have R5. 15a.; how much has A?

2. A and B together have R24. 1a., B and C together have R19. 15a., A and C together have R23. 12a.; find how much B has.

3. A horse and a cow are together worth R101, a cow and a sheep are together worth R31, a horse and a sheep are together worth R88; find the price of a horse, of a cow and of a sheep.

4 A mark and a gulden are together worth 2s. 11½d., a gulden and a rouble are together worth 5s. 1¾d., a rouble and a mark are together worth 4s. 1¼d.; find the value of a mark, of a gulden and of a rouble.

5. A man and woman together have R30. 7a. 6p., the woman and a boy together have R20. 8a., the man and the boy together have R25. 9a. 6p.; find how much the man, the woman and the boy together have.

XIX. FACTORS AND PRIME NUMBERS.

88. If one number divides another *exactly*, the first is said to be a **factor** (or *sub-multiple*) of the second, and the second is said to be a **multiple** of the first. Thus 5 is a factor of 15, and 15 is a multiple of 5.

In speaking of the factors of a number we exclude the number *one* or *unity*, which may be said to be a factor of any number.

[*N. B.* In the present section the word *divisible* is used in the sense of *exactly divisible.*]

89. An **even** number is a number divisible by 2. An **odd** number is a number not divisible by 2.

90. Criteria of Divisibility :

A number is divisible

by 2 when its last figure is 0, or an *even* digit ; as 310, 54 :

4 when its last *two* figures represent a number divisible by 4 ; as 300, 320, 324 :

8 when its last *three* figures represent a number divisible by 8 ; as 2000, 3400, 3240, 3816 :

5 when its last figure is 0 or 5 ; as 370, 345 :

10 when its last figure is 0 :

3 when the sum of its digits is divisible by 3 ; as 126, 402 :

9 when the sum of its digits is divisible by 9 ; as 477, 801 :

11 when the difference between the sum of its digits in the *odd* places and the sum of its digits in the *even* places is either 0, or divisible by 11 ; as 34672, 582934.

To determine whether a number is divisible by 7, 11, or 13 we have the following rule :

Divide the figures of the number into groups containing *three* each, as far as possible, counting from right to left. Add the alternate groups, and subtract the smaller sum from the greater ; then if the remainder is 0 or is divisible by 7, 11, or 13, the number itself is also divisible by 7, or by 11, or by 13.

Thus 98126 is divisible by 7, but not by 11 or by 13 : for $126-98=28$ which is divisible by 7, but not by 11 or by 13.

91. If a number is divisible separately by two (or more) numbers, it is divisible by their product.

If a number is divisible by 3 (or 9), any other number expressed by the *same digits* is also divisible by 3 (or 9).

If each of two numbers is divisible by a third number, their sum (and difference) is also divisible by the third.

If a number is divisible by another, any multiple of the first is also divisible by the second.

If each of two numbers is divisible by a third number, then the sum (and difference) of any multiple of the first and any multiple of the second is also divisible by the third number.

EXAMPLES. 53.

Determine whether the following numbers are divisible by 2, 3, 4, 5, 8, 9, 10 or 11 :

1. 138. **2.** 945. **3.** 684. **4.** 420. **5.** 8844.
6. 7942. **7.** 1230. **8.** 1772. **9.** 2311. **10.** 3475.
11. 8976. **12.** 7128. **13.** 12345. **14.** 98765. **15.** 35600.
16. 23000. **17.** 709281. **18.** 777777. **19.** 989898. **20.** 1234567890.

Determine whether the following numbers are divisible by 7, 11 or 13 :

21. 99120. **22.** 89133. **23.** 67119. **24.** 555555.
25. 433378. **26.** 4123210. **27.** 55734545. **28.** 123789666.

Determine whether the following numbers are divisible by 6, 12 or 30 :

29. 372. **30.** 948. **31.** 7740. **32.** 3725.

33. What is the least number which being added to 2311 will make the sum divisible (i) by 3, (ii) by 4 ?

34. What is the least number which being subtracted from 70031 will make the remainder divisible (i) by 5, (ii) by 8, (iii) by 9 ?

35. What number is the same multiple of 11 as 3705 is of 15 ?

92. A **prime number** or a **prime** is a number which is not divisible by any number (except itself and unity).

1, 2, 3, 5, 7, 11, 13, etc. are *prime* numbers.

A **composite** number is a number which has factors each greater than 1.

4, 6, 8, 9, 10, 12, etc. are *composite* numbers.

93. *To ascertain what numbers are primes.*

(i) To find the prime numbers in a series of numbers, 1, 2, 3,..., cancel every second number after 2, every third number after 3, every fifth number after 5, and so on ; the remaining numbers will

be primes. [In finding the primes in any series of numbers, we need not divide by any prime number whose square is greater than the largest number in the series.]

(ii) To determine whether a given number is a prime, divide the number successively by the primes 2, 3, 5, 7, 11, etc. ; if there is a remainder in each case the given number is a prime. [It is not necessary to try a divisor whose square is greater than the given number.]

Note. From Art. 90 it will appear that the units' figure of every prime number (except 2 and 5) must be 1, 3, 7 or 9. Hence any given number (not being 2 or 5) need only be examined when its units' figure is 1, 3, 7 or 9 ; and in such a case we need not try the divisors 2 and 5.

93a. The following a list of PRIME NUMBERS between 1 and 1009.

1	59	139	233	337	439	557	653	769	883
2	61	149	239	347	443	563	659	773	887
3	67	151	241	349	449	569	661	787	907
5	71	157	251	353	457	571	673	797	911
7	73	163	257	359	461	577	677	809	919
11	79	167	263	367	463	587	683	811	929
13	83	173	269	373	467	593	691	821	937
17	89	179	271	379	479	599	701	823	941
19	97	181	277	383	487	601	709	827	947
23	101	191	281	389	491	607	719	829	953
29	103	193	283	397	499	613	727	839	967
31	107	197	293	401	503	617	733	853	971
37	109	199	307	409	509	619	739	857	977
41	113	211	311	419	521	631	743	859	983
43	127	223	313	421	523	641	751	863	991
47	131	227	317	431	541	643	757	877	997
53	137	229	331	433	547	647	761	881	1009

94. Every composite number can be resolved into factors which are all primes.

Note A number has only one set of prime factors.

Example. Find the prime factors of 4452.

We divide the number successively (and in each case as often as possible) by those of the primes 2, 3, 5, 7, 11, 13,..., *that can be used as divisors*, until we come to a quotient which is a prime number.

$$\begin{array}{r|l} 2 & 4452 \\ \hline 2 & 2226 \\ \hline 3 & 1113 \\ \hline 7 & 371 \\ \hline & 53 \end{array}$$

Thus $4452 = 2 \times 2 \times 3 \times 7 \times 53$.

EXAMPLES. 54

Find the prime factors of

1.	8.	**2.**	12.	**3.**	18.	**4.**	24.	**5.**	27.
6.	32.	**7.**	48.	**8.**	50	**9.**	63.	**10.**	64.
11.	80	**12.**	88.	**13.**	99.	**14.**	100.	**15.**	108.
16.	176.	**17.**	117.	**18.**	288	**19.**	495	**20.**	625.
21.	999.	**22.**	1050.	**23.**	1296.	**24.**	1760.	**25.**	2000.
26.	3650.	**27.**	5760.	**28.**	2457.	**29.**	13824.	**30.**	200100.

Determine which of the following numbers are primes, and find the prime factors of those which are composite.

31.	29.	**32.**	61.	**33.**	81	**34.**	79.	**35.**	97.
36.	107.	**37.**	113	**38.**	207.	**39.**	227	**40.**	349.
41.	3751.	**42.**	507.	**43.**	4573.	**44.**	619.	**45.**	713.
46.	997.	**47.**	6539.	**48.**	1793.	**49.**	509.	**50.**	1363.

Find the number of primes between

51. 1 and 30. **52.** 10 and 50. **53.** 20 and 70.

54. By what prime numbers may 37 be divided, so that the remainder may be 2?

55. By what prime numbers may 109 be divided, so that the remainder may be 4?

56. By what numbers may 29 be divided, so that the remainder may be 5?

XX. HIGHEST COMMON FACTOR.

95. **A common factor** of two or more numbers is a number which divides each of them exactly.

Thus, each of the numbers 2, 3 and 6, is a *common factor* of 12 and 18.

The **Highest Common Factor (H. C. F.)** of two or more numbers is the *highest* number which divides each of them exactly.

Thus, 6 is the H. C. F. of 12 and 18.

Note. Two numbers are said to be *prime to each other* when they have no common factor.

N. B. The term *measure* is often used as synonymous with *factor*, and **Greatest Common Measure** instead of *highest common factor*.

96. *The H. C. F. of two or more numbers is the product of all their common prime factors.*

Example 1. Find the H. C. F. of 18 and 30.

$18 = 2 \times 3 \times 3$; $\quad 30 = 2 \times 3 \times 5$.

The factors common to the two numbers are 2 and 3; hence the H. C. F. required $= 2 \times 3 = 6$.

Note. In finding the H. C. F. it is not necessary to find the prime factors of all the numbers. It is sufficient to find the prime factors of one of the numbers, and to form the product of those that divide each of the remaining numbers exactly.

Example 2. Find the H. C. F. of 84, 140 and 168.

Now, $84 = 2 \times 2 \times 3 \times 7$; and we find that each of the remaining numbers is divisible by $2 \times 2 \times 7$, but not by 3; therefore the H. C. F. required $= 2 \times 2 \times 7 = 28$

EXAMPLES. 55.

Find, by the method of factors, the H. C. F. of

1. 9 and 24.	**2.** 20 and 48.	**3.** 35 and 80.
4. 126 and 144.	**5.** 90 and 325.	**6.** 252 and 348.
7. 1[illegible]nd 375.	**8.** 256 and 788.	**9.** 480 and 792.
10. 15, 35, 120.	**11.** 16, 24, 140.	**12.** 90, 125, 342.
13. 224, 336, 728.	**14.** 625, 750, 1225.	**15.** 868, 3164, 3228.

97. The following rule gives the most convenient method of finding the H. C. F. of two numbers:

Divide the greater number by the less, the divisor by the remainder, then the second divisor by the second remainder, and so on, until there is no remainder: the *last divisor* is the H. C. F. required.

Example 1. Find the H. C. F. of 384 and 1296.

```
Process :   384 ) 1296 ( 3
                  1152
                  ----
                   144 ) 384 ( 2
                         288
                         ---
                          96 ) 144 ( 1
                                96
                                --
                                48 ) 96 ( 2
                                     96
```

∴ The H. C. F. required is 48.

Note. When the H. C F of three or more numbers is required, we first find the H. C. F. of any two of them and then find the H. C F. of this result and another number, and so on, through all the given numbers ; the last result is the H. C. F. required.

Example 2. Find the greatest number that will divide 50 and 60 leaving the remainders 8 and 4 respectively.

$$50-8=42;\ 60-4=56.$$

∴ The number required = the H C. F. of 42 and 56 = 14.

EXAMPLES. 56.

Find the H C. F of

1. 48 and 144.	**2** 76 and 238.	**3.** 92 and 772.
4. 252, 348.	**5.** 493, 899	**6.** 620, 2108.
7. 2121, 1313.	**8.** 429, 715.	**9.** 377, 1131.
10. 1379, 2401.	**11.** 266, 2793	**12.** 3775, 10000.
13. 6023, 15466	**14.** 5865, 69180.	**15.** 4081, 5141.
16. 3556, 3444.	**17.** 5187, 5850.	**18.** 6441, 10283.
19. 13667. 14186.	**20.** 43365, 44688	**21.** 11050, 35581.
22. 12321, 54345.	**23.** 6327, 23997.	**24.** 13202, 146083.
25. 5325, 8307.	**26.** 9945, 50609.	**27.** 41[illegible]34720.
28. 109056, 179712	**29.** 218707, 826769.	**30.** 1[illegible]6, 987654.

Are the following prime to each other ?

31. 403 and 527.	**32.** 3370, 2703.	**33.** 387, 9234.
34. 1726, 1623.	**35.** 3890, 8275.	**33** 3480, 9448.
37. 211, 2701.	**38.** 5789, 7[illegible]7.	**39.** 9367, 14501.

Find the G. C. M. of

40. 703037 and 5134083. **41.** [illegible], 30599.

42. 805, 1311, 1978. **43.** 1204, 1190, 1445. **44.** 1617, 123, 789.

45. 1300, 728, 870, **46.** 723, 867, 735. **47.** 504, 2394, 2835.

48. 1190, 1445, 2006. **49.** 13338, 14136, 15903.

50. 314, 570, 618, 720. **51.** 602, 7394, 876, 92458.

52. What is the largest sum of money which is contained in R6. 4*a*. and R7. 8*a*. exactly ?

53. What is the largest sum of money which will divide £7. 7*s*. 6*d*. and £13. 17*s*. 9*d*. exactly ?

54. Find the greatest number that will divide 728 and 900, leaving remainders 8 and 4 respectively.

55. Find the greatest number that will divide 261, 933 and 1381, leaving the remainder 5 in each case.

56. Is there any number that will divide 620 and 730, leaving the remainders 3 and 7 respectively?

57. Two vats contain respectively 540 and 720 gallons; find the vessel of greatest capacity that will empty off both vats.

58. Two masses of gold weighing 4427 and 7219 tolas respectively are each to be made into coins of the same size; what is the weight of the largest possible coin?

59. A labourer was engaged for a certain number of days for R2 8*a.*, but being absent on some of those days he was paid only R1. 12*a.*; prove that his daily wages could not be more than 4 annas.

60. A woman bought a certain number of eggs for 15*a.* 6*p.*, and sold some of them without profit for 5*a.* 6*p.*; shew that she had still left *at least* 20 eggs.

XXI. LOWEST COMMON MULTIPLE.

98. A **common multiple** of two or more numbers is a number which is exactly divisible by each of them.

The **Lowest Common Multiple (L. C. M.)** of two or more numbers is the *lowest* number which is exactly divisible by each of them.

Thus, each of the numbers 12, 24 and 36, is a common multiple of 3, 4 and 6; but 12 is their *lowest* common multiple.

99. *The product of two numbers is equal to the product of their H. C. F. and L. C. M.* Thus, 2 is the H. C. F. and 12 is the L. C. M. of 4 and 6; and $4\times6=2\times12$.

Hence we have the following rule for finding the L. C. M. of **two numbers**:

Divide one of the numbers by the H. C. F. and multiply the quotient thus obtained by the other.

Example. Find the L. C. M. of 38 and 57.

The H. C. F. of 38 and $57=19$; $38\div19=2$.

$\therefore$ The L. C. M. required $=2\times57=114$.

Note. When the L. C. M. of three or more numbers is required, we find the L. C. M. of any two of the numbers, and then find the L. C. M. of this result and a third number, and so on; the last result being the L. C. M. required.

EXAMPLES. 57.

Find the L. C. M. of

1. 12 and 32. **2.** 76 and 98. **3.** 81 and 99. **4.** 320, 704.

5. 117, 192. **6.** 1224, 1696. **7.** 224, 336.

8. 754, 806. **9.** 957, 1001. **10.** 845, 899.

11. 779, 1197. **12.** 1287, 6281. **13.** 76, 96, 106.

14. 629, 851, 253. **15.** 265, 385, 495. **16.** 300, 906, 708.

17. Resolve 210 and 385 into their prime factors, and hence obtain their L. C. M.

18. Find the L. C. M. of 44, 54 and 72 by resolving them into their prime factors.

19. Find the L. C. M. of R3. 9*a*. 4*p*. and R7. 10*a*. 3*p*.

20. The H. C. F. and L. C M. of two numbers are 16 and 192 respectively; one of the numbers is 48 : find the other.

21. The H. C. F. and L. C. M. of two numbers are 10 and 30030 respectively; one of the numbers is 770 : what is the other?

100. The following rule gives the most convenient method of finding the L. C. M. of several small numbers.

Place the numbers side by side in a line; divide by any one of the prime numbers 2, 3, 5, 7, 11,......which will divide any two at least of the given numbers exactly; set down the quotients thus obtained and the undivided numbers side by side; and proceed in this way until you get a line of numbers which are prime to one another. The continued product of all the divisors and the numbers in the last line will be the L. C. M. required.

Example 1. Find the L. C. M. of 12, 18, 20 and 105.

Process :

$$\begin{array}{r|rrrr}
2 & 12, & 18, & 20, & 105 \\ \hline
2 & 6, & 9, & 10, & 105 \\ \hline
3 & 3, & 9, & 5, & 105 \\ \hline
5 & 1, & 3, & 5, & 35 \\ \hline
 & 1, & 3, & 1, & 7
\end{array}$$

L. C. M. $= 2 \times 2 \times 3 \times 5 \times 3 \times 7 = 1260$.

Note. Work may be shortened by rejecting, at *any* stage, from the line any one of the numbers, which is a factor of any other number in the same line.

Thus, if it is required to find the L. C. M. of 6, 12, 15, 30 and 40, it will be sufficient to find the L. C. M. of 12, 30 and 40.

Example 2. Find the least number which when divided by 12, 16 and 18, will leave in each case a remainder 5.

The L. C. M. of 12, 16 and 18 = 144.

∴ The number required = 144 + 5 = 149.

EXAMPLES. 58.

Find the L. C. M. of

1. 6, 8, 16.	**2.** 12, 16, 24.
3. 5, 18, 16, 9.	**4.** 9, 4, 18, 6.
5. 12, 15, 18, 24, 56.	**6.** 15, 16, 20, 28, 42.
7. 22, 17, 33, 25, 85.	**8.** 8, 9, 12, 18, 30.
9. 6, 15, 27, 35, 45.	**10.** 28, 36, 54, 72, 90.
11. 24, 10, 32, 45, 25.	**12.** 9, 18, 24, 72, 144.
13. 51, 187, 153, 165.	**14.** 33, 55, 60, 80, 90.
15. 22, 88, 132, 198.	**16.** 17, 51, 119, 210.
17. 50, 338, 675, 702, 975.	**18.** 24, 35, 52, 60, 91, 108
19. 315, 156, 126, 108, 91.	**20.** 27, 87, 203, 261, 189.
21. 126, 145, 87, 210, 585.	**22** 2, 3, 4, 5, 6, 7, 8, 9, 10.
23. 2, 4, 6, 8, 10, 12, 14, 16.	**24.** 15, 16, 18, 20, 24, 25, 27, 30.

25. 24, 35, 52, 60, 91, 108, 126, 156, 315.

26. Find the least number which when [illegible]ed by 12, 18 and 30, gives the same remainder 9 in each case.

27. Find the least number which when divided by 128 and 96 will leave in each case the same remainder 5.

28. Find the least number which being increased by 3, will be exactly divisible by 24, 36 and 48.

29. Find the smallest number of sq. inches which contains an exact number of sq. feet or of sq. cubits.

30 What is the smallest sum of money that can be paid in pounds, or in guineas, or in moidores ?

31. Five bells toll at intervals of 3, 5, 7, 8 and 10 seconds respectively, beginning together ; after what interval of time will they again toll together ?

32 Three men journey 10, 15 and 18 miles a day respectively ; find the least distance which would occupy each of them a complete number of days.

33. Two round pillars are 14 yd. 1 ft. 9 in. and 18 yd. 2 ft. 3 in. respectively in circumference ; find the shortest rope that can be wrapped round each an exact number of times.

34. A heap of shot when made up into groups of 28, 32 and 42, leaves always a remainder 5; find the least number of shot such heap can contain.

35. Find the least number which is divisible by all the numbers from 1 to 20 inclusive.

36. The circumferences of the wheels of a carriage are 6 ft. 3 in and 9 ft.; what is the least distance in which both the wheels will make an exact number of revolutions?

XXII. FRACTIONS.

101. When a quantity is composed solely of entire units, its measure is called a **whole number** or an **integer**.

[In sections II—XXI the word number has been used in the sense of a *whole number.*]

When a quantity is composed of one or more equal parts of the unit its measure is called a **fractional number** or a **fraction**.

Example. Two-thirds is a fraction; for two-thirds of the unit indicates a quantity which is composed of *two* equal parts, *three* of which make up the unit.

102 The number of equal parts into which the unit is divided, is called the **denominator** of the fraction; and the number of such parts taken to make up the quantity is called the **numerator** of the fraction. The numerator and denominator are called **terms** of the fraction.

A fraction is represented by writing the numerator above the denominator, with a horizontal line between them.

Thus, $\frac{4}{7}$ represents the fraction of which the numerator is 4, and the denominator is 7.

Such symbols are called *Fraction-symbols or Fractions.*

Note 1. The symbol $\frac{1}{2}$ is read *one-half*; $\frac{1}{3}$ is read *one-third*; $\frac{2}{3}$ is read *two-thirds*; $\frac{1}{4}$ is read *one-fourth*; $\frac{3}{4}$ is read *three-fourths*; and so on.

A fraction expressed in the above notation is called a **Vulgar Fraction.**

Example. '$\frac{2}{3}$ of a yard' indicates a quantity which is composed of *two* equal parts, *three* of which make up one yard; that is, '$\frac{2}{3}$ of a yard' = 2 feet.

Note 2. We should get the same result whether we divide a yard (or any other unit) into 3 equal parts and take 2 such parts, or divide 2 yards (or twice that other unit) into 3 equal parts and

take one of these parts. *A fraction may thus be considered to express the quotient of the numerator by the denominator.* Hence $\frac{2}{3}$ is often read '2 divided by 3'.

EXAMPLES. 59.

Write down the value of

1.	$\frac{1}{4}$ of Re 1.	2.	£$\frac{1}{5}$.	3.	$\frac{1}{2}d$.
4.	$\frac{1}{40}$ of a md.	5.	$\frac{6}{16}$ of Re 1.	6.	$\frac{9}{20}$ of £1.
7.	$\frac{7}{12}$ of a ft.	8.	$\frac{5}{12}$ of an anna.	9.	$\frac{10}{36}$ of a yd.
10.	$\frac{4}{12}$ of 1*s*.	11.	$\frac{3}{64}$ of Re 1.	12.	$\frac{3}{20}$ ton.
13.	$\frac{10}{176}$ mile.	14.	$\frac{3}{8}$ seer.	15.	$\frac{1}{16}$ sq. ft.
16.	$\frac{7}{112}$ cwt.	17.	$\frac{2}{3}$ of 15*a*.	18.	$\frac{2}{7}$ of Re 1. 5*a*.
19.	$\frac{4}{13}$ of 3 ft. 3 in.	20.	$\frac{8}{15}$ of $7\frac{1}{2}d$.	21.	$\frac{3}{13}$ of 1 hr. 5 min.

103. If the numerator and denominator of a fraction are each multiplied by the same number, the value of the fraction is not altered.

For, consider the fractions $\frac{2}{3}$ and $\frac{24}{36}$: the first indicates that the unit is divided into 3 equal parts and 2 of these parts are taken; the second indicates that the unit is divided into 36 equal parts and 24 of these parts are taken. Now, a part in the former case is obviously equal to 12 parts in the latter case; consequently 2 parts (taken) in the former case = 24 parts (taken) in the latter case.

$$\therefore \quad \frac{2}{3}=\frac{24}{36}\,;\ \text{and}\ \frac{24}{36}=\frac{2\times12}{3\times12}.$$

Illustration : $\frac{2}{3}$ of a yard = 2 ft. ; and $\frac{24}{36}$ of a yard = 24 in. = 2 ft.

Corollary. If the numerator and denominator of a fraction are each divided by the same number, the value of the fraction is not altered.

104. A whole number may be expressed as a fraction with *any* given denominator.

Thus for example, $3=\frac{3}{1}=\frac{6}{2}=\frac{9}{3}=\frac{12}{4}=$ etc.

105. A given fraction can be transformed into another fraction of which the denominator is any multiple of the given denominator.

Example. Transform $\frac{2}{3}$ into a fraction with the denominator 12.

$12=3\times4$; hence $\frac{2}{3}=\frac{2\times4}{3\times4}=\frac{8}{12}$. *Ans.*

EXAMPLES 60.

1. Express each of the whole numbers 2, 5, 7, 10 as a fraction with denominator 9.

2. Change 11 to fractions having 2, 9, 11, 25 and 35 for their denominators.

3. Express 21, 76 and 159 as fractions with denominators 5, 9 and 75 respectively.

4. Express $\frac{5}{6}$ and $\frac{7}{2}$ each as a fraction with denominators 12, 18, 96 and 600.

5. Find fractions equal to $\frac{1}{3}$, $\frac{3}{5}$, $\frac{7}{9}$, $\frac{2}{15}$, $\frac{13}{30}$, having 90 for their denominator.

6. Transform $\frac{33}{121}$, $\frac{32}{80}$ and $\frac{54}{90}$ into equivalent fractions whose denominators shall be 11, 5 and 10 respectively.

7. Express $\frac{35}{42}$, $\frac{50}{60}$, $\frac{49}{42}$ and $\frac{77}{66}$, each as a fraction with the denominator 6.

106. A fraction is said to be in its **lowest terms** when its numerator and denominator have no *common* factor.

Example 1. Reduce $\frac{630}{840}$ to its lowest terms.

We divide the numerator and denominator by their H. C. F. which is 210.

Thus $\frac{630}{840} = \frac{630 \div 210}{840 \div 210} = \frac{3}{4}$. *Ans.*

Note. In reducing a fraction to its lowest terms, it is convenient first to remove any factors common to both numerator and denominator, that can be found by inspection or by the application of the tests of divisibility (Art. 90).

Example 2. Reduce $\frac{78}{84}$ to its lowest terms.

Process : $\dfrac{\overset{\overset{13}{\cancel{39}}}{\cancel{78}}}{\underset{\underset{14}{\cancel{42}}}{\cancel{84}}} = \dfrac{13}{14}$ *Ans.*

Here, first 78 and 84 are divided by 2, giving quotients 39 and 42 ; next 39 and 42 are divided by 3, giving quotients 13 and 14 which are prime to each other ; hence the answer is $\frac{13}{14}$.

Example 3. Reduce by cancelling to their lowest terms :

(i) $\dfrac{2 \times 15}{35 \times 8}$; (ii) $\dfrac{3 \times 4 \times 5}{6 \times 20}$.

(i) $\dfrac{\cancel{2} \times \overset{3}{\cancel{15}}}{\cancel{35} \times 8} = \dfrac{3}{28}$. *Ans.* (ii) $\dfrac{\cancel{3} \times \cancel{4} \times \cancel{5}}{\cancel{6} \times \cancel{20}} = \dfrac{1}{2}$. *Ans.*

It should be borne in mind that when a factor is *cancelled*, it is replaced by 1 and not by 0.

EXAMPLES. 61.

Reduce to lowest terms :

1. $\frac{3}{6}$.	2. $\frac{4}{12}$.	3 $\frac{15}{30}$.	4 $\frac{12}{16}$.	5. $\frac{14}{21}$.
6. $\frac{18}{27}$.	7. $\frac{21}{28}$.	8. $\frac{18}{30}$	9. $\frac{16}{24}$.	10. $\frac{24}{72}$.
11. $\frac{24}{40}$	12. $\frac{40}{56}$.	13. $\frac{15}{45}$.	14 $\frac{33}{44}$.	15. $\frac{60}{80}$.
16. $\frac{19}{57}$.	17. $\frac{26}{78}$.	18 $\frac{51}{68}$.	19. $\frac{15}{100}$.	20 $\frac{34}{85}$.

EXAMPLES. 61a

Reduce to their lowest terms

1. $\frac{12}{15}$.	2 $\frac{16}{36}$.	3. $\frac{21}{70}$	4. $\frac{10}{75}$.	5. $\frac{57}{95}$.
6. $\frac{64}{128}$.	7. $\frac{171}{189}$.	8. $\frac{63}{144}$.	9. $\frac{147}{189}$.	10. $\frac{555}{999}$.
11. $\frac{875}{1000}$.	12 $\frac{720}{984}$.	13. $\frac{495}{1210}$.	14. $\frac{858}{1881}$.	15. $\frac{960}{1935}$
16 $\frac{3094}{3612}$	17. $\frac{1702}{1880}$.	18 $\frac{1485}{3180}$.	19. $\frac{5740}{6076}$.	20. $\frac{2300}{4515}$.
21. $\frac{1281}{1647}$.	22. $\frac{2376}{4914}$	23. $\frac{6544}{8032}$.	24. $\frac{1632}{2976}$	25 $\frac{2472}{3464}$.
26. $\frac{2763}{3615}$.	27. $\frac{2856}{4284}$.	28. $\frac{9648}{10224}$.	29 $\frac{30429}{38841}$.	30. $\frac{3200}{3840}$.
31. $\frac{7569}{9504}$.	32. $\frac{8308}{29193}$.	33. $\frac{48510}{49005}$.	34 $\frac{711285}{993999}$.	35. $\frac{115795}{222210}$.

EXAMPLES. 61b.

Reduce by cancelling to their simplest forms :

1. $\frac{3\times4}{8\times6}$.	2 $\frac{7\times15}{5\times14}$.	3. $\frac{15\times4}{12\times5}$.
4. $\frac{6\times16\times15}{8\times9\times40}$.	5. $\frac{8\times14\times24}{48\times35\times7}$.	6. $\frac{7\times9\times24}{56\times21\times18}$.
7. $\frac{3\times25\times11}{55\times30\times4}$.	8. $\frac{6\times81\times77}{33\times55\times72}$.	9. $\frac{80\times90\times42}{100\times72\times16}$.
10. $\frac{17\times63\times4}{35\times3\times6}$.	11. $\frac{7\times9\times10}{24\times28\times5}$.	12. $\frac{15\times21\times19}{35\times48\times7}$.

107. A **mixed number** is composed of a whole number and a fraction, as $3\frac{2}{5}$. This stands for $3+\frac{2}{5}$, and is read '*three and two-fifths*'.

A mixed number can be expressed as a fraction.

Example. Express $4\frac{2}{3}$ as a fraction.

$$4\tfrac{2}{3}=4+\tfrac{2}{3}=\tfrac{12}{3}+\tfrac{2}{3}=\tfrac{14}{3}.$$

For, 12 thirds of the unit and 2 thirds of the unit make (12+2) or 14 thirds of the unit.

Hence the rule : Multiply the whole number by the denominator of the fractional part ; add the result to the numerator of that part for the new numerator, and retain the same denominator.

EXAMPLES. 62.

Express the following mixed numbers as fractions :

1. $3\frac{1}{3}$.	2. $7\frac{2}{5}$.	3. $9\frac{3}{11}$.	4. $8\frac{7}{10}$.	5. $5\frac{1}{3}$.
6. $7\frac{1}{100}$.	7. $12\frac{3}{70}$.	8. $20\frac{3}{20}$.	9. $39\frac{2}{41}$.	10. $90\frac{1}{90}$.
11. $29\frac{7}{200}$.	12. $76\frac{13}{36}$.	13. $25\frac{23}{25}$.	14. $111\frac{100}{111}$.	15. $99\frac{19}{90}$.
16. $7\frac{43}{100}$.	17. $8\frac{329}{1000}$.	18. $22\frac{33}{101}$.	19. $40\frac{4}{301}$.	20. $4\frac{4}{99}$.

108. A **proper** fraction is one, of which the numerator is less than the denominator, as $\frac{3}{5}$.

An **improper** fraction is one, of which the numerator is equal to or greater than the denominator, as $\frac{3}{3}$, $\frac{7}{5}$.

An improper fraction is either equal to an integer or a mixed number.

Example. Reduce $\frac{21}{7}$ and $\frac{29}{6}$ to whole or mixed numbers.

$$\frac{21}{7}=\frac{3\times7}{1\times7}=\frac{3}{1}=3. \qquad \frac{29}{6}=\frac{24}{6}+\frac{5}{6}=4+\frac{5}{6}=4\frac{5}{6}.$$

Hence the rule : Divide the numerator by the denominator ; the quotient will be the integral part of the mixed number ; the remainder will be the numerator, and the denominator of the given fraction the denominator, of the fractional part.

(i)	(ii)
$7\,)\,\underline{21}$	$6\,)\,\underline{29}$
3, rem. 0.	4, rem. 5.
Hence $\frac{21}{7}=3$.	Hence $\frac{29}{6}=4\frac{5}{6}$.

109. The **reciprocal** of a fraction is a fraction formed by interchanging its terms ; thus the reciprocal of $\frac{3}{5}$ is $\frac{5}{3}$, of 4 (or $\frac{4}{1}$) is $\frac{1}{4}$.

EXAMPLES. 63.

Express as whole or mixed numbers :

1. $\frac{7}{2}$.	2. $\frac{9}{4}$.	3. $\frac{13}{3}$.	4. $\frac{21}{4}$.	5. $\frac{22}{7}$.
6. $\frac{30}{8}$.	7. $\frac{45}{5}$.	8. $\frac{72}{12}$.	9. $\frac{98}{16}$.	10. $\frac{85}{17}$.
11. $\frac{39}{14}$.	12. $\frac{56}{14}$.	13. $\frac{90}{18}$.	14. $\frac{80}{17}$.	15. $\frac{60}{19}$.
16. $\frac{300}{70}$.	17. $\frac{301}{101}$.	18. $\frac{702}{99}$.	19. $\frac{250}{12}$.	20. $\frac{875}{125}$.

Express the reciprocals of the following fractions as whole or mixed numbers :

21. $\frac{180}{3741}$.	22. $\frac{1}{519}$.	23. $\frac{76}{7691}$.	24. $\frac{75}{750}$.	25. $\frac{30}{2500}$.
26. $\frac{7009}{7897}$.	27. $\frac{425}{2975}$.	28. $\frac{125}{1257}$.	29. $\frac{60}{500}$.	30. $\frac{1825}{5000}$.

110. Two or more given fractions may be reduced to equivalent fractions having the lowest common denominator.

Example. Reduce $\frac{2}{9}$, $\frac{5}{12}$ and $\frac{3}{10}$ to equivalent fractions having the lowest common denominator.

The denominators are 9, 12 and 10; their L. C. M. is 180.

$$180 \div 9 = 20, \quad \therefore \quad \frac{2}{9} = \frac{2 \times 20}{9 \times 20} = \frac{40}{180};$$

$$180 \div 12 = 15, \quad \therefore \quad \frac{5}{12} = \frac{5 \times 15}{12 \times 15} = \frac{75}{180};$$

$$180 \div 10 = 18, \quad \therefore \quad \frac{3}{10} = \frac{3 \times 18}{10 \times 18} = \frac{54}{180}.$$

Hence $\frac{2}{9}$, $\frac{5}{12}$ and $\frac{3}{10} = \frac{40}{180}$, $\frac{75}{180}$ and $\frac{54}{180}$ respectively; and these latter have the lowest common denominator.

EXAMPLES. 64.

Reduce to equivalent fractions having the least common denominator:

1. $\frac{1}{3}$ and $\frac{5}{6}$
2. $\frac{3}{10}$ and $\frac{4}{15}$.
3. $\frac{7}{18}$ and $\frac{3}{20}$.
4. $\frac{1}{2}, \frac{1}{3}, \frac{1}{4}$.
5. $\frac{2}{3}, \frac{3}{4}, \frac{4}{5}$.
6. $\frac{5}{6}, \frac{6}{7}, \frac{7}{8}$.
7. $\frac{3}{8}, \frac{7}{6}, \frac{5}{12}$.
8. $\frac{4}{15}, \frac{7}{18}, \frac{21}{50}$.
9. $\frac{5}{16}, \frac{7}{24}, \frac{11}{40}$.
10. $\frac{2}{15}, \frac{3}{20}, \frac{1}{100}$.
11. $\frac{21}{50}, \frac{7}{60}, \frac{61}{90}$.
12. $\frac{1}{25}, \frac{9}{45}, \frac{3}{80}$.
13. $3\frac{1}{3}, 4\frac{1}{4}, 6\frac{1}{6}$.
14. $2, \frac{1}{6}, \frac{1}{8}$.
15. $3, 5, \frac{7}{12}$.
16. $\frac{1}{7}, 3\frac{1}{3}, 2, \frac{3}{5}$.
17. $3, \frac{1}{3}, 4, \frac{1}{4}$.
18. $\frac{1}{2}, \frac{1}{3}, \frac{1}{4}, \frac{1}{5}, \frac{1}{6}$.
19. $\frac{1}{11}, \frac{3}{22}, \frac{4}{77}, \frac{3}{14}, 1$.
20. $\frac{1}{3}, \frac{3}{5}, \frac{5}{7}, \frac{7}{9}, \frac{9}{11}$.
21. $\frac{73}{80}, \frac{11}{15}, \frac{13}{24}, \frac{31}{40}, \frac{117}{100}$.
22. $2, 2\frac{1}{3}, \frac{7}{12}, \frac{4}{5}, 1\frac{1}{16}$.
23. $\frac{1}{10}, \frac{1}{16}, \frac{1}{50}, \frac{1}{32}, \frac{1}{100}$.
24. $2, 3\frac{1}{3}, 7\frac{1}{4}, \frac{5}{16}, \frac{1}{3}$.
25. $\frac{4}{5}, \frac{9}{11}, \frac{1}{33}, \frac{7}{60}, \frac{1}{40}$.
26. $3, 7\frac{1}{2}, 2\frac{1}{3}, \frac{5}{6}, \frac{7}{8}$.
27. $1\frac{1}{7}, \frac{5}{7}, \frac{1}{2}, \frac{1}{4}, \frac{5}{16}, 2\frac{1}{14}$.

111. Of two fractions having a common denominator the *greater* is that which has the *greater* numerator.

Thus, of the fractions $\frac{7}{12}$ and $\frac{5}{12}$, the former is obviously greater.

Of two fractions having a common numerator the *greater* is that which has the *less* denominator.

Thus, of the fractions $\frac{5}{8}$ and $\frac{5}{9}$ the former is greater.

Note. In comparing values of fractions, they must be reduced to equivalent fractions having the L. C. D. or L. C. N.

EXAMPLES. 65.

Which is greater,

1. $\frac{3}{5}$ or $\frac{4}{7}$?
2. $\frac{7}{11}$ or $\frac{9}{13}$?
3. $\frac{8}{15}$ or $\frac{13}{20}$?
4. $\frac{21}{25}$ or $\frac{13}{20}$?
5. $\frac{7}{8}$ or $\frac{8}{9}$?
6. $\frac{29}{47}$ or $\frac{31}{53}$?

Find the greatest and the least of the following fractions :

7. $\frac{15}{16}, \frac{19}{20}, \frac{24}{25}$. 8. $\frac{7}{8}, \frac{9}{10}, \frac{10}{11}$. 9. $\frac{20}{51}, \frac{30}{85}, \frac{19}{34}$.

10. $\frac{2}{5}, \frac{15}{18}, \frac{12}{17}, \frac{1}{2}$. 11. $\frac{3}{7}, \frac{5}{13}, \frac{7}{16}, \frac{9}{20}$. 12. $\frac{5}{16}, \frac{7}{24}, \frac{11}{36}, \frac{9}{28}$.

Arrange in order of magnitude :

13. $\frac{3}{4}, \frac{5}{6}, \frac{7}{12}$. 14. $\frac{7}{16}, \frac{18}{35}, \frac{4}{45}$. 15. $\frac{3}{5}, \frac{7}{9}, \frac{11}{13}$.

16. $\frac{15}{4}, 3\frac{2}{3}, \frac{27}{8}$. 17. $\frac{21}{25}, \frac{26}{30}, \frac{31}{35}$. 18. $\frac{27}{87}, \frac{118}{341}, \frac{148}{428}$.

19. $\frac{6}{7}, \frac{13}{25}, \frac{4}{9}, \frac{5}{8}$. 20. $\frac{51}{76}, \frac{113}{152}, \frac{7}{12}, \frac{2}{3}$. 21. $\frac{3}{4}, \frac{9}{20}, \frac{11}{15}, \frac{17}{12}$.

ADDITION AND SUBTRACTION OF FRACTIONS.

112. Addition.—The sum of fractions having a common denominator is a fraction whose numerator is the sum of the numerators, and whose denominator is the common denominator, of the original fractions (see Art. 107). When fractions to be added have different denominators, they must be reduced to equivalent fractions having the L. C. D.

Example 1. Add together $\frac{7}{5}, \frac{3}{5}$ and $\frac{4}{5}$.

Process : $\frac{7}{5}+\frac{3}{5}+\frac{4}{5}=\frac{7+3+4}{5}=\frac{14}{5}=2\frac{4}{5}$. *Ans.*

Example 2. Add together $\frac{1}{2}, \frac{5}{6}$ and $\frac{4}{9}$.

The L. C. M. of 2, 6 and 9 = 18.

$\frac{1}{2}+\frac{5}{6}+\frac{4}{9}=\frac{9}{18}+\frac{15}{18}+\frac{8}{18}=\frac{9+15+8}{18}=\frac{32}{18}=\frac{16}{9}=1\frac{7}{9}$. *Ans.*

Note. The sum should always be expressed in its lowest terms ; and if an improper fraction, should be reduced to a mixed number.

EXAMPLES. 66.

Add together

1. $\frac{1}{4}, \frac{3}{4}, \frac{5}{4}$. 2. $\frac{2}{7}, \frac{3}{7}, \frac{4}{7}$. 3. $\frac{1}{9}, \frac{2}{9}, \frac{5}{9}$.

4. $\frac{7}{11}, \frac{2}{11}, \frac{8}{11}$. 5. $\frac{7}{10}, \frac{13}{10}, \frac{8}{10}$. 6. $\frac{21}{50}, \frac{30}{50}, \frac{18}{50}$.

7. $\frac{8}{48}, \frac{19}{48}, \frac{23}{48}$. 8. $\frac{3}{100}, \frac{731}{100}, \frac{6}{100}$. 9. $\frac{12}{65}, \frac{18}{65}, \frac{51}{65}$.

10. $\frac{1}{2}, \frac{1}{3}$. 11. $\frac{2}{3}, \frac{3}{4}$. 12. $\frac{7}{8}, \frac{5}{12}$.

13. $\frac{3}{16}, \frac{7}{20}, \frac{8}{15}$. 14. $\frac{9}{20}, \frac{13}{27}, \frac{5}{18}$. 15. $\frac{21}{50}, \frac{9}{16}, \frac{7}{12}$.

Simplify

16. $\frac{1}{2}+\frac{2}{3}+\frac{3}{4}$. 17. $\frac{5}{12}+\frac{5}{16}+\frac{5}{20}$. 18. $\frac{2}{27}+\frac{8}{15}+\frac{9}{20}$.

19. $\frac{1}{9}+\frac{1}{12}+\frac{1}{15}$. 20. $\frac{2}{7}+\frac{1}{4}+\frac{5}{8}$. 21. $\frac{1}{6}+\frac{3}{4}+\frac{2}{15}$.

22. $\frac{1}{3}+\frac{1}{9}+\frac{1}{18}+\frac{1}{27}$. 23. $\frac{7}{8}+\frac{7}{10}+\frac{7}{12}+\frac{7}{15}$. 24. $\frac{3}{5}+\frac{5}{6}+\frac{9}{16}+\frac{15}{8}$.

25. $\frac{3}{14}+2\frac{1}{7}+\frac{3}{7}+\frac{1}{2}$. 26. $\frac{13}{15}+\frac{14}{35}+\frac{1}{6}+\frac{1}{32}$. 27. $\frac{7}{12}+\frac{11}{18}+\frac{27}{36}+\frac{14}{15}$.

28. $\frac{113}{126}+\frac{335}{336}+\frac{655}{675}$. 29. $\frac{31}{147}+\frac{219}{228}+\frac{7}{64}$. 30. $\frac{7}{10}+\frac{19}{17}+\frac{17}{20}+\frac{29}{37}$.

113. In adding mixed numbers it is convenient to proceed as in the following example :

Example. Add together $2\frac{1}{2}$, $3\frac{1}{4}$ and $7\frac{5}{6}$.

Process : $2\frac{1}{2}+3\frac{1}{4}+7\frac{5}{6}=2+3+7+\frac{1}{2}+\frac{1}{4}+\frac{5}{6}$

$$=12+\frac{6}{12}+\frac{3}{12}+\frac{10}{12}$$

$$=12+\frac{6+3+10}{12}$$

$$=12+\frac{19}{12}=12+1\frac{7}{12}=13\frac{7}{12}. \quad \textit{Ans.}$$

N. B. It is also convenient to reduce improper fractions to mixed numbers.

EXAMPLES. 67.

Add

1. $3\frac{1}{2}+4\frac{1}{4}$.
2. $7\frac{1}{3}+6\frac{5}{6}$.
3. $5\frac{1}{10}+7\frac{1}{4}$.
4. $13\frac{1}{6}+2\frac{3}{5}$.
5. $3\frac{1}{3}+5\frac{1}{6}+15\frac{1}{15}$.
6. $7\frac{1}{7}+8\frac{1}{8}+14\frac{1}{14}$.
7. $2\frac{1}{2}+\frac{1}{8}+3$.
8. $31+9\frac{2}{3}+\frac{11}{12}$.
9. $1\frac{1}{11}+2\frac{2}{33}+\frac{99}{14}$.
10. $7\frac{3}{17}+2+\frac{100}{51}$.
11. $3\frac{1}{7}+4\frac{1}{21}+6\frac{1}{28}+1\frac{1}{14}$.
12. $2\frac{1}{6}+3\frac{1}{3}+4\frac{1}{2}+1\frac{7}{15}$.
13. $3\frac{1}{77}+\frac{200}{7}+\frac{320}{11}$.
14. $\frac{333}{50}+\frac{721}{30}+4$.
15. $2\frac{1}{4}+3+1\frac{1}{2}+\frac{55}{8}$.
16. $1+\frac{99}{4}+2\frac{1}{2}+3\frac{1}{16}$.
17. $\frac{1000}{7}+\frac{1000}{2}+\frac{1000}{3}$.
18. $\frac{9}{5}+\frac{99}{4}+\frac{999}{8}$.
19. $10+3\frac{1}{7}+\frac{222}{49}+\frac{1}{21}$.
20. $\frac{7}{3}+\frac{11}{9}+\frac{17}{15}+\frac{29}{18}$.

21.

R	a.	p.
7	9	$2\frac{1}{2}$
5	10	$7\frac{11}{12}$
13	14	$6\frac{2}{3}$
2	7	$0\frac{11}{18}$

22.

£.	s.	d.
1	9	$2\frac{3}{8}$
2	0	$5\frac{3}{4}$
3	7	$0\frac{15}{16}$
1	0	$3\frac{1}{2}$

23.

yd.	ft.	in.
7	1	$3\frac{3}{4}$
2	2	$2\frac{1}{3}$
3	0	$7\frac{3}{8}$
2	1	$5\frac{6}{11}$

24.

lb.	oz.	dr.
1	7	$7\frac{1}{2}$
2	9	$3\frac{3}{4}$
3	13	$0\frac{5}{8}$
4	3	$7\frac{3}{16}$

25.

oz.	dwt.	gr.
3	10	$7\frac{2}{3}$
7	0	$8\frac{5}{6}$
8	3	$0\frac{4}{9}$
2	7	$2\frac{1}{2}$

26.

hr.	min.	sec.
3	20	$9\frac{1}{4}$
7	22	$19\frac{7}{8}$
4	7	$29\frac{9}{16}$
5	34	$34\frac{6}{7}$

114. Subtraction.—The method of subtraction of fractions is similar to that of addition.

Example 1. Subtract $\frac{2}{7}$ from $\frac{4}{7}$.

Process : $\frac{4}{7}-\frac{2}{7}=\frac{4-2}{7}=\frac{2}{7}$. *Ans.*

Example 2. Subtract $\frac{3}{8}$ from $\frac{5}{6}$.

The L. C. M. of 8 and 6 = 24.

$\frac{5}{6}-\frac{3}{8}=\frac{20}{24}-\frac{9}{24}=\frac{20-9}{24}=\frac{11}{24}$. *Ans.*

EXAMPLES. 68.

Perform the following subtractions :

1. $\frac{30}{49}-\frac{23}{49}$. 2. $\frac{71}{8}-\frac{23}{8}$. 3. $\frac{1}{2}-\frac{1}{3}$. 4. $\frac{1}{3}-\frac{1}{4}$.
5. $\frac{7}{8}-\frac{3}{16}$. 6. $\frac{7}{18}-\frac{7}{24}$. 7. $\frac{8}{15}-\frac{8}{25}$. 8. $\frac{13}{10}-\frac{1}{30}$.
9. $\frac{29}{48}-\frac{31}{64}$. 10. $\frac{5}{14}-\frac{3}{21}$. 11. $\frac{13}{20}-\frac{7}{30}$. 12. $\frac{101}{100}-\frac{101}{600}$.
13. $\frac{9}{5}-\frac{5}{9}$. 14. $7\frac{1}{2}-2\frac{1}{7}$. 15. $1\frac{7}{16}-1\frac{1}{8}$. 16. $\frac{8}{9}-\frac{11}{18}$.
17. $\frac{5}{3}-1\frac{1}{3}$. 18. $2\frac{2}{3}-2\frac{1}{9}$. 19. $7\frac{5}{8}-7\frac{3}{16}$. 20. $\frac{17}{88}-\frac{22}{77}$.
21. $1-\frac{5}{12}$. 22. $1-\frac{7}{13}$. 23. $1-\frac{8}{15}$. 24. $1-\frac{19}{30}$.

115. The following examples are important.

Example 1. Subtract $3\frac{2}{5}$ from $7\frac{5}{8}$.

Process : $7\frac{5}{8}-3\frac{2}{5}=7\frac{25}{40}-3\frac{16}{40}=7-3+\frac{25}{40}-\frac{16}{40}=4+\frac{9}{40}=4\frac{9}{40}$. *Ans.*

Example 2. Subtract $2\frac{2}{3}$ from $4\frac{1}{5}$.

Process : $4\frac{1}{5}-2\frac{2}{3}=4\frac{3}{15}-2\frac{10}{15}=3\frac{18}{15}-2\frac{10}{15}=3-2+\frac{18}{15}-\frac{10}{15}$
$=1+\frac{8}{15}=1\frac{8}{15}$. *Ans.*

Example 3. Subtract $\frac{5}{12}$ from 7.

Process : $7-\frac{5}{12}=6+1-\frac{5}{12}=6+\frac{7}{12}=6\frac{7}{12}$. *Ans.*

Example 4. Subtract $3\frac{1}{4}$ from 9.

Process : $9-3\frac{1}{4}=6-\frac{1}{4}=5+1-\frac{1}{4}=5+\frac{3}{4}=5\frac{3}{4}$. *Ans.*

EXAMPLES. 69.

Perform the following subtractions :

1. $8\frac{1}{2}-5\frac{1}{3}$. 2. $9\frac{3}{8}-7\frac{1}{4}$. 3. $3\frac{1}{3}-\frac{8}{9}$. 4. $5\frac{7}{8}-\frac{1}{4}$.
5. $12\frac{3}{8}-7\frac{1}{3}$. 6. $17\frac{6}{17}-12\frac{13}{51}$. 7. $8\frac{13}{21}-2\frac{7}{28}$. 8. $10\frac{13}{30}-2\frac{1}{15}$.
9. $5\frac{1}{3}-2\frac{1}{2}$. 10. $7\frac{3}{5}-3\frac{5}{6}$. 11. $8\frac{1}{12}-7\frac{3}{16}$. 12. $23\frac{1}{31}-17\frac{1}{7}$.
13. $5\frac{29}{84}-2\frac{41}{48}$. 14. $12\frac{13}{28}-3\frac{20}{49}$. 15. $34\frac{1}{5}-24\frac{1}{7}$. 16. $50\frac{7}{81}-40\frac{8}{27}$.
17. $39\frac{19}{63}-28\frac{20}{21}$. 18. $9\frac{5}{12}-2\frac{1}{4}$. 19. $7\frac{1}{3}-\frac{5}{6}$. 20. $10\frac{1}{6}-\frac{3}{8}$.
21. $3-\frac{4}{9}$. 22. $7-\frac{3}{8}$. 23. $9-\frac{11}{12}$. 24. $10-\frac{19}{17}$.
25. $12-3\frac{4}{5}$. 26. $17-4\frac{9}{11}$. 27. $18-4\frac{1}{18}$. 28. $20-9\frac{19}{21}$.

Simplify

29. $2\frac{1}{2}+3\frac{1}{3}-4\frac{1}{4}$. 30. $7\frac{1}{5}+9\frac{7}{15}-10\frac{1}{3}$.
31. $3\frac{1}{7}+4\frac{1}{5}-1\frac{1}{2}$. 32. $17\frac{1}{2}-3\frac{1}{4}-7\frac{1}{8}$.
33. $9\frac{5}{18}-8\frac{1}{2}+3\frac{1}{4}$. 34. $12\frac{1}{15}-7\frac{1}{3}-2\frac{1}{5}$.
35. $8-2\frac{1}{3}+7\frac{1}{5}-3\frac{7}{15}$. 36. $7-3\frac{13}{18}-2\frac{5}{9}+\frac{8}{27}$.

37. $7-\frac{100}{7}+\frac{200}{21}+\frac{300}{28}$.
38. $7-\frac{3}{8}+8-\frac{1}{7}$.

39. $\frac{13}{14}-7\frac{1}{2}+9-2\frac{1}{7}$.
40. $3\frac{1}{3}+4\frac{1}{4}-5\frac{1}{5}-2\frac{1}{20}$.

41. Subtract R2. 13*a*. $4\frac{3}{4}$*p*. from R13. 9*a*. 6*p*.

42. Subtract R7. 10*a*. $5\frac{2}{7}$*p*. from R10. 7*a*. 3*p*.

43. Subtract R2. 13*a*. $11\frac{3}{8}$*p*. from R7. 2*a*. $3\frac{1}{4}$*p*.

44. Subtract £3. 17*s*. $9\frac{7}{8}$*d*. from £14. 7*s*. $3\frac{5}{16}$*d*.

45. Subtract £4. 7*s*. $3\frac{4}{5}$*d*. from £10. 0*s*. $2\frac{1}{10}$*d*.

46. Subtract 7 yd. 2 ft. $9\frac{3}{4}$ in. from 14 yd. 0 ft. $3\frac{1}{8}$ in.

MULTIPLICATION AND DIVISION OF FRACTIONS.

116. To multiply a fraction by a whole number, we multiply the numerator by that number, leaving the denominator unchanged.

Thus $\frac{2}{17}\times 3=\frac{2}{17}+\frac{2}{17}+\frac{2}{17}=\frac{2+2+2}{17}=\frac{2\times 3}{17}=\frac{6}{17}$.

Example 1. $\frac{4}{21}\times 14=\frac{4\times 14}{21}=\frac{4\times 2}{3}=\frac{8}{3}=2\frac{2}{3}$.

Example 2. $23\frac{2}{3}\times 5=23\times 5+\frac{2}{3}\times 5=115+\frac{10}{3}=115+3\frac{1}{3}=118\frac{1}{3}$.

Example 3. Multiply $\frac{99}{100}$ by 57.

Since $\frac{99}{100}=1-\frac{1}{100}$,

$\frac{99}{100}\times 57=57-\frac{57}{100}=56+1-\frac{57}{100}=56+\frac{43}{100}=56\frac{43}{100}$.

Example 4. Multiply $99\frac{99}{100}$ by 7.

Since $99\frac{99}{100}=100-\frac{1}{100}$,

$99\frac{99}{100}\times 7=700-\frac{7}{100}=699+1-\frac{7}{100}=699+\frac{93}{100}=699\frac{93}{100}$.

EXAMPLES. 70.

Multiply

1. $\frac{2}{3}$ by 7.
2. $\frac{7}{8}$ by 8.
3. $\frac{11}{12}$ by 11.
4. $\frac{3}{7}$ by 9.
5. $\frac{3}{14}$ by 10.
6. $\frac{13}{18}$ by 15.
7. $\frac{17}{20}$ by 30.
8. $\frac{100}{101}$ by 303.
9. $\frac{2}{15}$ by 21.
10. $\frac{7}{24}$ by 36.
11. $\frac{15}{34}$ by 51.
12. $\frac{19}{35}$ by 70.
13. $\frac{70}{473}$ by 110.
14. $\frac{47}{112}$ by 144.
15. $\frac{13}{95}$ by 570.
16. $\frac{12}{169}$ by 91.
17. $3\frac{1}{3}$ by 4.
18. $6\frac{4}{5}$ by 7.
19. $7\frac{3}{7}$ by 9.
20. $8\frac{5}{13}$ by 12.
21. $2\frac{27}{35}$ by 12.
22. $5\frac{7}{36}$ by 12.
23. $29\frac{7}{8}$ by 11.
24. $9\frac{13}{18}$ by 21.
25. $3\frac{17}{18}$ by 54.
26. $4\frac{11}{12}$ by 249.
27. $3\frac{43}{112}$ by 144.
28. $2\frac{3}{20}$ by 88.
29. $\frac{99}{100}$ by 29.
30. $\frac{96}{100}$ by 39.
31. $\frac{999}{1000}$ by 19.
32. $\frac{188}{189}$ by 45.
33. $99\frac{99}{100}$ by 9.
34. $9\frac{9}{10}$ by 39.
35. $999\frac{999}{1000}$ by 23.
36. $99\frac{7}{10}$ by 32.
37. $9\frac{97}{100}$ by 21.
38. $319\frac{7}{80}$ by 20.

39. 7*s.* $7\frac{7}{12}$*d.* by 5. **40.** 9*s.* $11\frac{6}{13}$*d.* by 9.
41. R7. 3*a.* $3\frac{3}{7}$*p.* by 7. **42.** R8. 3*a.* $4\frac{7}{8}$*p.* by 6.
43. 4*s.* $0\frac{5}{11}$*d.* by 11. **44.** £3. 0*s.* $7\frac{3}{16}$*d.* by 12.

117. To divide a fraction by a whole number, we multiply the denominator by the whole number, leaving the numerator unchanged.

Thus $\frac{2}{3} \div 5 = \frac{2}{3 \times 5} = \frac{2}{15}$: for, a part of the unit in $\frac{2}{15}$ is one-fifth of a part in $\frac{2}{3}$, and since the same number of parts is taken in both cases, $\frac{2}{15}$ is one-fifth of $\frac{2}{3}$.

Example 1. $7\frac{1}{2} \div 10 = \frac{15}{2} \div 10 = \frac{15}{2 \times 10} = \frac{3}{2 \times 2} = \frac{3}{4}$.

Example 2. Divide $3759\frac{2}{3}$ by 5.

Process : $5 \,)\, \underline{3759\frac{2}{3}}$
$\qquad 751, \quad 4\frac{2}{3}$ rem.

Now $4\frac{2}{3} \div 5 = \frac{14}{3} \div 5 = \frac{14}{15}$; $\therefore \; 3759\frac{2}{3} \div 5 = 751\frac{14}{15}$.

Note. In the division of integers by integers, the complete quotients can always be obtained by the aid of fractions. Thus for example, $320 \div 9 = \frac{320}{9} = 35\frac{5}{9}$.

EXAMPLES. 71.

Divide

1. $\frac{1}{2}$ by 4 **2.** $\frac{2}{3}$ by 5. **3.** $\frac{3}{4}$ by 7. **4.** $\frac{7}{9}$ by 7.
5. $\frac{9}{16}$ by 12. **6.** $\frac{21}{29}$ by 28. **7.** $\frac{66}{72}$ by 22. **8.** $\frac{99}{110}$ by 11.
9. $\frac{700}{740}$ by 5. **10.** $\frac{70}{149}$ by 42. **11.** $\frac{121}{160}$ by 88. **12.** $\frac{63}{121}$ by 54.
13. $\frac{54}{65}$ by 135. **14.** $\frac{64}{71}$ by 160. **15.** $\frac{133}{128}$ by 95. **16.** $\frac{145}{343}$ by 87.
17. $7\frac{1}{3}$ by 4. **18.** $3\frac{3}{4}$ by 9. **19.** $3\frac{2}{5}$ by 85. **20.** $4\frac{5}{6}$ by 11.
21. $16\frac{2}{3}$ by 15. **22.** $4\frac{3}{4}$ by 57. **23.** $3\frac{7}{8}$ by 21. **24.** $2\frac{6}{7}$ by 40.
25. $213\frac{1}{3}$ by 5. **26.** $73\frac{5}{6}$ by 6. **27.** $713\frac{3}{8}$ by 4. **28.** $100\frac{1}{3}$ by 15.
29. $333\frac{19}{20}$ by 21. **30.** $356\frac{1}{32}$ by 33. **31.** $999\frac{7}{8}$ by 16.
32. $729\frac{11}{12}$ by 19. **33.** $324\frac{2}{7}$ by 15. **34.** $39\frac{1}{3}$ by 24.
35. R10. 12*a.* $2\frac{1}{2}$*p.* by 8. **36.** R22. 13*a.* $3\frac{1}{4}$*p.* by 9.
37. £20. 7*s.* $6\frac{3}{8}$*d.* by 11. **38.** £99. 19*s.* $11\frac{11}{13}$*d.* by 13.

Obtain the complete quotient in the division of

39. 720 by 9. **40.** 1346 by $7\frac{1}{2}$. **41.** 1000 by 23. **42.** 1234 by 11.
43. R29. 7*a.* by R7. 3*a.* **44.** R2. 14*a* 6*p.* by 1*a.* 9*p.*
45. £728. 11*s.* by £3. 7*s.* **46.** £100. 7*s.* $6\frac{1}{2}$*d.* by 4*s.* 8*d.*
47. R20. 8*a.* 3*p.* by 8. **48.** R13. 12*a.* 6*p.* by 11.

49. R420 7a. 9p. by 13. **50.** R100. 3a. 11p. by 16.

51. £17. 17s. 7d. by 5. **52.** £59. 19s. 11d. by 15.

118. The definition of multiplication which we have given in Art. 29 implies that the multiplier is a whole number, and it is not applicable when the multiplier is a fraction. We therefore give below the general definition of multiplication.

Def. To multiply one given number by another is to perform upon the number multiplied that operation which is performed upon unity to obtain the multiplier.

Since 1 is repeated three times to obtain the number 3, to multiply a number by 3 is to repeat that number three times.

Again, since 1 is divided into 3 equal parts and two of these parts are taken to obtain the number $\frac{2}{3}$, to multiply a number by $\frac{2}{3}$ is to divide that number into three equal parts and take two of these parts; that is, to multiply a number by $\frac{2}{3}$ we have to divide the number by 3 and multiply the result by 2.

Example. Multiply $\frac{3}{8}$ by $\frac{2}{7}$.

Since $\frac{3}{8} \div 7 = \frac{3}{8 \times 7}$; and $\frac{3}{8 \times 7} \times 2 = \frac{3 \times 2}{8 \times 7}$;

$\therefore \frac{3}{8} \times \frac{2}{7} = \frac{3 \times 2}{8 \times 7} = \frac{6}{56}$. *Ans.*

Hence the rule: To multiply one fraction by another, multiply the numerators for the numerator of the product, and multiply the denominators for its denominator.

[*N. B.* This rule holds good for the continued product of three or more fractions.]

Note. Hence it is clear that $\frac{3}{8} \times \frac{2}{7} = \frac{2}{7} \times \frac{3}{8}$.

119. A **compound** fraction is a fraction of a fraction; as $\frac{2}{3}$ of $\frac{4}{5}$.

The compound fraction, $\frac{2}{3}$ of $\frac{4}{5}$, means that we are to divide $\frac{4}{5}$ (regarded as a whole) into 3 equal parts and take 2 of these parts. Hence $\frac{2}{3}$ of $\frac{4}{5}$ is equivalent to $\frac{4}{5} \times \frac{2}{3}$, *i. e.*, to $\frac{2}{3} \times \frac{4}{5}$.

Example. Simplify $3\frac{7}{9}$ of $9\frac{3}{8}$.

$3\frac{7}{9}$ of $9\frac{3}{8} = 3\frac{7}{9} \times 9\frac{3}{8} = \frac{34}{9} \times \frac{75}{8} = \frac{34 \times 75}{9 \times 8} = \frac{17 \times 25}{3 \times 4} = \frac{425}{12} = 35\frac{5}{12}$. *Ans.*

N. B. Before effecting the multiplication, common factors should be removed from the numerator and denominator.

EXAMPLES. 72.

Multiply,

1. [illegible] by [illegible]. 2. $\frac{7}{8}$ by $\frac{3}{4}$. 3. $\frac{8}{9}$ by [illegible].

4. $\frac{12}{25}$ by $\frac{10}{9}$. 5. $\frac{39}{44}$ by $\frac{66}{13}$. 6. $\frac{18}{65}$ by $\frac{39}{80}$.
7. $\frac{27}{51}$ by $\frac{34}{45}$. 8. $\frac{36}{85}$ by $\frac{34}{81}$. 9. $5\frac{3}{4}$ by $\frac{3}{46}$.
10. $3\frac{3}{4}$ by $\frac{8}{9}$. 11. $\frac{25}{39}$ by $2\frac{3}{5}$. 12. $\frac{36}{49}$ by $3\frac{1}{2}$.
13. $4\frac{3}{11}$ by $7\frac{1}{2}$. 14. $7\frac{3}{4}$ by $3\frac{1}{3}$. 15. $2\frac{3}{5}$ by $1\frac{2}{13}$.
16. $4\frac{4}{9}$ by $3\frac{3}{10}$. 17. $2\frac{1}{5}$ by $3\frac{4}{7}$. 18. $3\frac{7}{11}$ by $2\frac{1}{3}$.
19. $5\frac{5}{12}$ by $5\frac{1}{4}$. 20. $3\frac{3}{5}$ by $4\frac{5}{6}$. 21. $2\frac{1}{3}$ by $4\frac{1}{2}$.

Simplify

22. $3\frac{1}{2}$ of $2\frac{2}{7}$. 23. $\frac{1}{4}$ of $4\frac{1}{2}$ of $3\frac{1}{3}$. 24. $2\frac{1}{2}$ of $3\frac{1}{3}$ of $4\frac{1}{5}$.
25. $\frac{2}{3}$ of $1\frac{2}{3} \times 7\frac{1}{5}$. 26. $4\frac{1}{3} \times \frac{27}{52}$ of $4\frac{7}{26}$. 27. $1\frac{3}{4} \times 2\frac{1}{7} \times 3\frac{2}{5}$.
28. $\frac{1}{2}$ of $2\frac{1}{3} \times 3\frac{3}{5}$ of 9. 29. $3\frac{2}{3}$ of $2\frac{3}{4} \times 4 \times 7\frac{1}{5}$.
30. $\frac{2}{3}$ of $\frac{9}{13}$ of $\frac{39}{16}$. 31. $3\frac{4}{5} \times 5\frac{3}{4}$ of $\frac{2}{19} \times 1\frac{1}{46}$.
32. $4\frac{1}{2} \times 2\frac{1}{5} \times 1\frac{1}{6}$ of $2\frac{1}{2}$. 33. $\frac{1}{3}$ of $\frac{3}{4}$ of $2\frac{1}{5}$.
34. $\frac{3}{4} \times \frac{7}{8} \times \frac{10}{9} \times \frac{4}{21} \times 1\frac{1}{2}$. 35. $\frac{1}{2}$ of $\frac{4}{5}$ of $\frac{1}{4}$ of $\frac{2}{3}$ of $\frac{5}{6}$.
36. $2\frac{1}{2}$ of $3\frac{1}{4} \times 1\frac{1}{3}$ of $2\frac{2}{13} \times 1\frac{1}{8}$. 37. $\frac{1}{4}$ of $9 \times 7\frac{1}{2} \times 4\frac{2}{3}$ of $\frac{7}{8}$ of $\frac{4}{5}$.

120. *Example.* Reduce 29 poles to inches.

Process :

$$\begin{array}{rl}
29 & \text{po.} \\
5\frac{1}{2} & \\
\hline
145 & = 29 \times 5. \\
14\frac{1}{2} & = 29 \div 2,\ i.e.,\ 29 \times \frac{1}{2}. \\
\hline
159\frac{1}{2} & \text{yd.} \\
3 & \\
\hline
478\frac{1}{2} & \text{ft.} \\
12 & \\
\hline
5742 & \text{in.}
\end{array}$$

EXAMPLES. 73.

Reduce to inches :

1. 7 po. 2. 13 po. 3. 29 po. 4. 39 po. 5. 49 po.
6. 4 fur. 39 po. 5 yd. 7. 10 mi. 5 fur. 0 po. 3 yd.

Reduce to sq. inches :

8. 7 sq. po. 9. 13 sq. po. 10. 29 sq. po. 11. 39 sq. po.
12. 49 sq. po. 13. 9 ac. 2 ro. 7 po. 14. 1 sq. mi. 3 ac. 10 po.

121. Division by a fraction is the *inverse* of multiplication.

To divide $\frac{5}{6}$ by $\frac{3}{4}$ is to find that number which being multiplied by $\frac{3}{4}$ gives $\frac{5}{6}$ as the product. But $\frac{5}{6} \times \frac{4}{3}$ being multiplied by $\frac{3}{4}$ gives $\frac{5}{6}$ as the product ($\because \frac{4}{3} \times \frac{3}{4} = 1$); therefore $\frac{5}{6} \div \frac{3}{4} = \frac{5}{6} \times \frac{4}{3}$: and hence

we have the rule . Multiply the dividend by the reciprocal of the divisor.

Example 1. $8\frac{1}{4} \div 3\frac{2}{3} = \frac{33}{4} \div \frac{11}{3} = \frac{33}{4} \times \frac{3}{11} = \frac{3\times 3}{4} = \frac{9}{4} = 2\frac{1}{4}$ *Ans.*

Example 2 If $\frac{3}{5}$ of a number is 4, what is the number ?
Here the product of the number (required) by $\frac{3}{5}$ is 4 ,
$\therefore$ the number required $= 4 \div \frac{3}{5} = \frac{4}{1} \times \frac{5}{3} = \frac{20}{3} = 6\frac{2}{3}$

EXAMPLES 74.

Divide

1, $\frac{4}{5}$ by $\frac{2}{5}$. 2. $\frac{3}{4}$ by $\frac{5}{9}$ 3 $\frac{7}{12}$ by $\frac{41}{36}$ 4. $\frac{56}{63}$ by $\frac{4}{7}$
5 $3\frac{1}{3}$ by $2\frac{1}{3}$ 6 $7\frac{7}{8}$ by $\frac{1}{16}$ 7 $\frac{42}{7}$ by $1\frac{1}{21}$. 8 $\frac{7}{15}$ by $\frac{40}{33}$
9 $11\frac{4}{25}$ by $\frac{3}{5}$. 10. $16\frac{2}{3}$ by $12\frac{1}{2}$ 11 $\frac{3}{5}$ by $\frac{18}{35}$ 12 $11\frac{1}{11}$ by $12\frac{1}{2}$
13. [illegible] by $1\frac{1}{9}$. 14 $13\frac{1}{8}$ by $2\frac{1}{10}$ 15 $10\frac{1}{3}$ by $\frac{10}{17}$ 16 9 by $\frac{21}{25}$.
17. $14\frac{2}{7}$ by $5\frac{2}{7}$. 18. $11\frac{1}{4}$ by $7\frac{1}{2}$ 19. 10 by $7\frac{1}{2}$. 20. 76 by $28\frac{1}{2}$
21. $\frac{2}{3}$ of $4\frac{1}{2}$ by $7\frac{1}{2}$ of $3\frac{3}{4}$ 22. $3\frac{1}{3} \times 6\frac{3}{4}$ by $1\frac{1}{8} \times 14$
23 $4\frac{1}{3} + 7\frac{1}{16}$ by $4\frac{3}{4} - 2\frac{7}{4}$ 24 $3\frac{3}{4}$ of $3\frac{1}{4}$ by $7 - 3\frac{1}{3}$.
25. $\frac{7}{9}$ of a number is 14 , what is the number ?
26. $3\frac{1}{?}$ of a number is $2\frac{1}{3}$; what is the number ?
27 Find the number, $\frac{2}{3}$ of which is $\frac{4}{5}$ of $\frac{7}{9}$
28. $3\frac{1}{3}$ of $4\frac{1}{5}$ of a number is 7 find the number
29. $\frac{1}{2}$ of $\frac{4}{5}$ of a number is $3\frac{1}{3}$ of 10 , what is the number ?
30. Which is greater, the quotient of $3\frac{1}{2}$ by $6\frac{1}{2}$ or the continued product of $\frac{2}{3}$, $\frac{4}{5}$ and $\frac{6}{7}$?

H. C. F AND L. C. M. OF FRACTIONS

122 The definitions which we have given of the H. C. F. and L. C. M. of two or more whole numbers will also be applicable when the given numbers are fractions, provided that we understand by *exact division*, that the complete quotients must be *integers*.

Rule To find the H. C. F. or the L. C. M. of fractions, reduce them to their least common denominator ; then find the H. C. F or the L. C. M. of the new numerators, and write it over the common denominator.

Example Find the H. C. F. and L. C. M. of $\frac{3}{4}$, $2\frac{1}{2}$ and $\frac{15}{16}$.
The given fractions are equivalent to $\frac{12}{16}$, $\frac{40}{16}$, $\frac{15}{16}$;
the H. C. F. of 12, 40 and 15 = 1, and their L. C. M. = 120 ;
$\therefore$ the H. C. F. required $= \frac{1}{16}$;
and the L. C. M. required $= \frac{120}{16} = \frac{15}{2} = 7\frac{1}{2}$.

EXAMPLES. 75

Find the H. C. F. and L. C. M. of

1. $\frac{1}{3}$ and $\frac{1}{4}$. 2. $\frac{9}{16}$ and $\frac{3}{4}$. 3. $\frac{8}{21}$ and $\frac{16}{35}$.
4. $\frac{2}{3}, \frac{4}{5}, \frac{8}{9}$. 5. $\frac{4}{5}, \frac{5}{6}, \frac{6}{15}$. 6. $3\frac{1}{2}, 5\frac{1}{4}, \frac{1}{12}$.
7. $\frac{39}{32}, \frac{3}{4}, 3\frac{1}{2}$. 8. $\frac{7}{8}, 8\frac{2}{5}, \frac{77}{85}$. 9 $2\frac{1}{2}, 3\frac{1}{2}, 4\frac{1}{2}$.
10. $3, \frac{9}{2}, 10\frac{1}{2}$. 11. $\frac{100}{21}, \frac{98}{35}, 4$. 12. $1\frac{37}{75}, 2\frac{64}{85}, 5\frac{35}{39}$.

13. What is the greatest length which is contained a whole number of times exactly in both $7\frac{1}{2}$ feet and $4\frac{1}{2}$ feet ?

14. Find the least number which, when divided by each of the fractions $\frac{4}{5}$, $\frac{3}{10}$ and $\frac{12}{25}$, gives a whole number as quotient in each case.

15. Four bells commence tolling together ; they toll at intervals of 1, $1\frac{1}{4}$, $1\frac{1}{2}$ and $1\frac{3}{4}$ seconds respectively ; after what interval will they toll together again ?

MISCELLANEOUS EXAMPLES. 76.

1 What number must be added to $3\frac{1}{3}$ of $\frac{1}{5}$ that the sum may be 9 ?

2. What must we take from $3\frac{1}{3}$ to leave $2\frac{1}{3}$?

3. From what must be $4\frac{1}{2}$ be taken to leave $\frac{2}{3}$ of $\frac{3}{4}$?

4. What number multiplied by $\frac{3}{4}+\frac{5}{8}$ gives the product $\frac{3}{4}-\frac{5}{8}$?

5. By what do we divide $\frac{4}{5}$, if the quotient is 8 ?

6. How many times does $\frac{1}{2}+\frac{1}{3}$ contain $\frac{1}{2}-\frac{1}{3}$?

7. What number do we divide by $7\frac{1}{2}$, if the quotient is $2\frac{1}{2}$?

8. If the divisor be $\frac{1}{4}$, and quotient $\frac{5}{8}$ of the divisor, what is the dividend ?

9. Find the price of 217 lb. at $5\frac{1}{4}d.$ per lb.

10. Find the cost of 325 maunds at Rs. 9a. $4\frac{1}{2}p.$ per maund.

11. Find the weight of 125 boxes, each $7\frac{3}{8}$ lb.

12. R720 is $\frac{9}{16}$ of what amount ?

13. Find the sum of money, $\frac{3}{4}$ of which is £30.

14. Which is the greatest, $4\frac{5}{8}+3\frac{1}{3}$, $4\frac{1}{3}\times 3\frac{1}{3}$, $4\frac{1}{2}-3\frac{1}{4}$ or $4\frac{1}{3}+3\frac{1}{3}$?

15. What number is that from which if you subtract $\frac{1}{2}-\frac{1}{3}$, and to the remainder add $\frac{1}{2}$ of $\frac{1}{3}$, the sum will be $\frac{1}{2}+\frac{1}{3}$?

16. Find the least fraction which being added to $\frac{7}{9}$ shall make the result an integer.

17. A gives B $\frac{1}{3}$ of his money ; B gives C $\frac{1}{4}$ of what he receives ; and C gives D $\frac{1}{5}$ of what he receives ; what fraction of A's money does D receive ?

18. If I lose $\frac{3}{8}$ of my money, what fraction of it have I left?
[The fraction $=1-\frac{3}{8}=\frac{5}{8}$.]

18a. $\frac{2}{5}$ of a post are imbedded in mud, $\frac{3}{10}$ are in the water, and 6 ft. are above the surface, what is the length of the post?
[$\frac{2}{5}+\frac{3}{10}=\frac{7}{10}$; $1-\frac{7}{10}=\frac{3}{10}$. $\therefore$ $\frac{3}{10}$ of the post $=6$ ft.;
and $\therefore$ the length of the post $=6$ ft $\div\frac{3}{10}=6\times\frac{10}{3}$ ft. $=20$ ft.]

19 A book contains 25 pages, and a boy has read 15 of them; what fraction of the whole has he yet to read?

20. A sum of money is divided among three persons, *A*, *B* and *C*. *A* receives $\frac{3}{8}$ of it, and *B* receives $\frac{2}{5}$. How much does *C* get?

21. A man owns $\frac{5}{18}$ of an estate, and sells $\frac{1}{3}$ of his share; what fraction of the estate does he still own?

22. A merchant owned $\frac{13}{16}$ of a ship, and sold $\frac{5}{16}$ of his share; what part of the whole ship had he left?

23. If I give away $\frac{3}{10}$ of my money, and then $\frac{3}{8}$ of what remains, how much of the whole is left?

24. One-fifth of an estate is left to the eldest son, $\frac{1}{6}$ to the second, and $\frac{5}{8}$ of the remainder to the third; how much was over?

[illegible]s first game a person loses $\frac{1}{4}$ of his money, at the [illegible]mainder, at the third $\frac{1}{3}$ of the rest, what fraction of his original money has he left?

26 When $1\frac{1}{2}$ of $\frac{3}{8}$ of a loaf of bread has been eaten, how much of the loaf will be left?

27. After paying $\frac{3}{8}$ of a bill, R24 is still due; what was the amount of the bill?

28 A person expends $\frac{1}{3}$ of his income in board and lodging, $\frac{1}{8}$ in clothing and $\frac{1}{10}$ in charity, and saves £318. What is his income?

29. A boy after giving away $\frac{1}{4}$ of his pocket-money to one companion, and $\frac{1}{3}$ of the remainder to another, has 2*s*. left. How much had he at first?

30 A man travelled $\frac{3}{11}$ of his journey by coach, $\frac{7}{15}$ by rail, and walked the remaining 9 miles; how far did he go?

31. One-tenth of a rod is coloured red, one-twentieth orange, one-thirtieth yellow, one-fortieth green, one fiftieth blue, one-sixtieth indigo, and the remainder which is 302 inches long, violet. Find the length of the rod.

32 Of a certain dynasty $\frac{1}{3}$ of the kings were of the same name, $\frac{1}{4}$ of another, $\frac{1}{5}$ of another, $\frac{1}{15}$ of a fourth, and there were 5 besides. How many kings were there of each name?

[illegible]3. How many whole cakes would be wanted for 100 children [illegible]each has a third of a cake?

34. By what number should $\frac{8}{6}\frac{1}{8}\frac{1}{2}$ be multiplied so as to produce the least possible integer?

35. Simplify $\dfrac{£7.\ \ 5s.}{£14.\ \ 5s.} - \dfrac{1 \text{ ton } \ 5 \text{ cwt.}}{4 \text{ tons } 15 \text{ cwt.}}$

36. How often may $\frac{7}{8}$ be subtracted from 7, so as to leave a remainder not less than 3?

37. From a rope 20 ft. long, as many pieces as possible are cut off, each $2\frac{3}{8}$ ft. long; what fraction of the latter length will be left?

38. A cistern has two pipes attached to it, one to supply and one to draw off. The first can supply $\frac{3}{4}$ of a gallon, and the second can draw off $\frac{4}{5}$ of a gallon, per minute. If both the pipes are opened when the cistern contains 81 gallons, how soon will the cistern be empty?

39. The double and fourth part of a number, added together, give $7\frac{1}{2}$ as the result; what is the number?

40. Find the number, of which the eighth part exceeds the tenth part by 7.

41. What are the nearest integers to $12\frac{5}{8}$ and $17\frac{3}{7}$? Give reasons for your answer.

42. A number of mangoes is to be divided amongst 3 persons so that one may get $\frac{5}{12}$ of it, another $\frac{7}{18}$, and the third the remainder; what must the number *at least* be that this may be done without cutting any of the mangoes?

XXIII. COMPLEX FRACTIONS.

123. A **simple** fraction is one, in which the numerator and denominator are both whole numbers; as $\frac{3}{7}$, $\frac{8}{5}$.

A **complex** fraction is one, in which the numerator or denominator or both are not whole numbers; as

$$\frac{\frac{2}{3}}{5},\quad \frac{7}{2\frac{1}{2}},\quad \frac{3\frac{2}{3}}{4\frac{5}{6}},\quad \frac{\frac{3}{4}+1\frac{1}{6}}{3\frac{1}{4} \text{ of } 2\frac{5}{6}}.$$

Note. $\dfrac{3\frac{2}{3}}{4\frac{5}{6}}$ is read '$3\frac{2}{3}$ divided by $4\frac{5}{6}$', or '$3\frac{2}{3}$ by $4\frac{5}{6}$.'

124. Complex fractions can always be *simplified* as in the following examples:

Example 1. $\dfrac{\frac{2}{3}}{5}\left[=\frac{2}{3}\div 5=\frac{2}{3}\div\frac{5}{1}\right]=\frac{2}{3}\times\frac{1}{5}=\frac{2}{15}.$

Example 2. $\dfrac{7}{2\frac{1}{2}}\left[=7\div 2\frac{1}{2}=\frac{7}{1}\div\frac{5}{2}\right]=\frac{7}{1}\times\frac{2}{5}=\frac{14}{5}=2\frac{4}{5}.$

Example 3. $\frac{3\frac{2}{5}}{4\frac{2}{3}}\left[=3\frac{2}{5}\div4\frac{2}{3}=\frac{17}{5}\div\frac{14}{3}\right]=\frac{17}{5}\times\frac{3}{14}=\frac{51}{70}.$

Example 4. $\frac{\frac{2}{3}+1\frac{1}{2}}{3\frac{1}{4}\text{ of }2\frac{2}{3}}=\frac{\frac{2}{3}+\frac{3}{2}}{\frac{13}{4}\times\frac{8}{3}}=\frac{\frac{13}{6}}{\frac{26}{3}}=\frac{13}{6}\times\frac{3}{26}=\frac{1}{4}.$

N. B The work within the brackets may be omitted in practice

Note. There is another method of simplifying complex fractions, which is explained by the following example.

Example 5. Simplify $\frac{4\frac{1}{2}-3\frac{1}{3}}{\frac{3}{4}+\frac{5}{6}}$.

We multiply the terms of the fraction by 12, the L. C. M of the denominators 2, 3, 4 and 6.

Thus the fraction $=\frac{54-40}{9+10}=\frac{14}{19}.$

EXAMPLES. 77.

Simplify

1. [illegible] 2. $\frac{13}{8\frac{2}{3}}$. 3. [illegible] 4. $\frac{7\frac{1}{2}}{\frac{5}{8}}$. 5. $\frac{1\frac{3}{10}}{4\frac{1}{2}}$.

6. $\frac{9\frac{5}{14}}{13\frac{1}{21}}$. 8. $\frac{99\frac{1}{10}}{24\frac{7}{11}}$. 9. $\frac{\frac{1}{2}+\frac{1}{3}}{3\frac{1}{3}}$. 10. $\frac{3-\frac{3}{4}}{3+\frac{3}{4}}$.

11. $\frac{[illegible]}{\frac{5}{6}\times\frac{5}{16}}$. 12. $\frac{3\frac{2}{7}+1\frac{1}{4}}{4\frac{1}{2}-3\frac{1}{5}}$. 13. $\frac{7\frac{1}{2}-3\frac{1}{3}}{\frac{3}{5}+\frac{5}{6}}$. 14. $\frac{10\frac{1}{10}\text{ of }7\frac{1}{7}}{\frac{1}{2}+\frac{1}{4}}$.

15. $\frac{1\frac{1}{2}+2\frac{1}{3}+3\frac{1}{4}}{\frac{1}{2}-\frac{1}{3}+\frac{1}{4}}$. 16. $\frac{5\frac{1}{3}\text{ of }2\times\frac{7}{8}}{7\frac{1}{7}-3\frac{1}{4}}$. 17. $\frac{7}{4\frac{1}{5}}+\frac{2\frac{1}{3}}{7}$. 18. $\frac{3\frac{1}{3}}{1\frac{1}{3}}-1\frac{1}{4}$.

19. $\frac{7\frac{1}{2}}{1\frac{1}{2}}+\frac{2\frac{1}{4}}{\frac{3}{4}}-\frac{4\frac{1}{2}}{7}$. 20. $\frac{3}{14}\text{ of }\frac{4\frac{2}{3}}{6\frac{2}{3}}\text{ of }\frac{6\frac{8}{11}}{11\frac{1}{3}}$. 21. [illegible]

22. $\frac{2\frac{1}{3}}{2\frac{1}{3}}+\frac{5\frac{1}{2}-2\frac{1}{3}}{3\frac{1}{4}+9\frac{1}{2}}$. 23. $\frac{\frac{2\frac{1}{4}}{54}+\frac{1}{8}-\frac{1}{216}+\frac{1}{12}}{\frac{1}{2}+\frac{1}{3}+\frac{1}{6}}$ [illegible] 24. [illegible]

125. *Example.* Simplify the continued fraction [illegible]

$$3+\cfrac{2}{[illegible]-\cfrac{2}{4+\cfrac{5}{6+\frac{1}{2}}}}$$

Process: $3+\cfrac{1}{7-\cfrac{2}{4+\cfrac{5}{6+\frac{1}{2}}}}=3+\cfrac{1}{7-\cfrac{2}{4+\frac{10}{13}}}=3+\cfrac{1}{7-\frac{13}{31}}$

$$=3+\frac{31}{204}=3\frac{31}{204}. \quad \textit{Ans}$$

EXAMPLES 78

Simplify

1. $\cfrac{1}{1+\cfrac{1}{1+\frac{1}{2}}}$
2. $\cfrac{2}{2-\cfrac{2}{2+\frac{1}{2}}}$
3. $\cfrac{3}{3+\cfrac{3}{3-\frac{1}{3}}}$
4. $2+\cfrac{3}{4+\cfrac{5}{7+\frac{5}{6}}}$
5. $3-\cfrac{1}{4+\cfrac{7}{2-\frac{1}{3}}}.$
6. $7+\cfrac{8}{3-\cfrac{9}{4+\frac{1}{3}}}.$
7. $1+\cfrac{1}{2+\cfrac{1}{3+\cfrac{1}{4+\frac{1}{5}}}}$
8. $6+\cfrac{1}{6-\cfrac{1}{6+\cfrac{1}{6-\frac{1}{6}}}}.$
9. $2\frac{1}{2}+\cfrac{5}{2+\cfrac{5}{2+\cfrac{5}{2+\frac{1}{2}}}}$
10. $\cfrac{1}{4-\cfrac{1}{2-\cfrac{1}{1-\cfrac{1}{3+\frac{1}{2}}}}}.$
11. $\cfrac{1}{2+\cfrac{1}{2+\cfrac{1}{2+\cfrac{1}{2+\frac{1}{2}}}}}$
12. $\cfrac{1}{2-\cfrac{2}{2+\cfrac{4}{2-\cfrac{5}{2+\frac{5}{6}}}}},$

126. The following examples of simplification are important.

Example 1. [illegible] $=2\frac{1}{2}$.

Example 2. [illegible]

Example 3. [illegible]

Example 4. [illegible] etc.

In the above examples the operations of division are converted into those of multiplication by inverting the fractions which are preceded by the sign of division; [illegible] division by a fraction is equivalent to multiplication by its reciprocal.

Note. In simplifying an [illegible] compound fraction must be treated as a single number. The difference in meaning between [illegible] of [illegible] and [illegible] should be noticed.

$$\text{[illegible] of [illegible]} = 6;$$

but [illegible]

EXAMPLES. 79.

Simplify

1. $\frac{7}{8} \div 5\frac{1}{4} \div 2\frac{3}{5}$. 2. $1\frac{1}{3} \div 1\frac{1}{2} \div 1\frac{1}{9}$. 3. $\frac{3}{5} \div 2\frac{1}{2} \times 2\frac{7}{10}$.
4. $2\frac{3}{4} \div \frac{1}{2} \times 1\frac{1}{11}$. 5. $2\frac{1}{3} \times \frac{3}{4} \div 1\frac{3}{4}$. 6. $2\frac{1}{4} \times 1\frac{1}{2} \div 2\frac{2}{5}$.
7. $1\frac{1}{2} \div 1\frac{1}{3} \times 2\frac{1}{4} \div 2\frac{2}{5}$. 8. $\frac{1}{9} \times \frac{7}{8} \div \frac{1}{3} \times \frac{4}{7} \div \frac{2}{3} \div \frac{1}{2}$. 9. $3\frac{1}{2} \div 1\frac{3}{4} \div \frac{4}{5} \times \frac{1}{2}$.
10. $\frac{1}{9} \div \frac{7}{8} \times \frac{1}{3} \div \frac{4}{9} \div \frac{2}{3} \times \frac{1}{2}$. 11. $3\frac{1}{4} \div 2\frac{1}{3}$ of $6\frac{1}{2}$. 12. $2\frac{1}{2} \div 3\frac{1}{3}$ of $4\frac{1}{4}$.
13. $2\frac{1}{2} \div 3\frac{1}{3} \times 4\frac{1}{4}$. 14. $2\frac{1}{2} \times \frac{3}{4} \div 3\frac{1}{3}$ of $1\frac{1}{5}$. 15. $4\frac{2}{3} \times 2\frac{1}{2} \div 1\frac{3}{4}$ of $3\frac{1}{3}$.
16. $2\frac{1}{2}$ of $\frac{3}{4} \div 3\frac{1}{3} \times 1\frac{1}{8}$. 17. $4\frac{2}{3}$ of $2\frac{1}{2} \div 1\frac{3}{4} \times 3\frac{1}{3}$.
18. $2\frac{1}{2}$ of $\frac{3}{4} \div 3\frac{1}{3}$ of $1\frac{1}{8}$. 19. $4\frac{2}{3}$ of $2\frac{1}{2} \div 1\frac{3}{4}$ of $3\frac{1}{3}$.
20. $2\frac{1}{2} \times \frac{3}{4} \div 3\frac{1}{3} \times 1\frac{1}{8}$. 21. $4\frac{2}{3} \times 2\frac{1}{2} \div 1\frac{3}{4} \times 3\frac{1}{3}$.
22. $1\frac{1}{2} \div 2\frac{1}{3}$ of $3\frac{1}{4} \times 1\frac{1}{3}$. 23. $1\frac{1}{2} \div 2\frac{1}{3} \times 3\frac{1}{4}$ of $1\frac{1}{3}$.
24. $1\frac{1}{2} \times 2\frac{1}{3} \times 3\frac{1}{4} \div 1\frac{1}{3}$ of $2\frac{1}{4}$ of $3\frac{1}{3} \times \frac{9}{13}$

127. Convention of Signs :—When an expression contains all (or some of) the signs +, −, ×, and ÷, *the multiplication and division are to be worked before the addition and subtraction.*

Example. $\frac{5}{2} + 2 \times \frac{1}{4} \div \frac{1}{3} - \frac{1}{2} = \frac{5}{2} + \frac{2}{1} \times \frac{1}{4} \times \frac{3}{1} - \frac{1}{2} = \frac{5}{2} + \frac{3}{2} - \frac{1}{2} = 4 - \frac{1}{2} = 3\frac{1}{2}$.

EXAMPLES. 80.

Simplify

1. $1\frac{1}{7}$ of $3\frac{1}{2} - \frac{4}{15}$ of $3\frac{3}{4}$. 2. $2\frac{1}{2} \times \frac{3}{5} + 7\frac{1}{2} \times \frac{4}{15}$. 3. $\frac{2}{3} \div 1\frac{5}{7} - \frac{5}{8} \div 3\frac{2}{11}$.
4. $17\frac{1}{2} - 3\frac{1}{4} \times 4\frac{3}{13} + \frac{1}{13}$. 5. $3\frac{1}{13} + 4\frac{1}{2} \div \frac{2}{3} - \frac{1}{2}$. 6. $2\frac{3}{4} + 1\frac{3}{4}$ of $\frac{3}{14} - 1\frac{1}{2}$.
7. $5\frac{1}{2} + 3\frac{1}{3} \times 4\frac{1}{5} - 7$ of $\frac{11}{14}$. 8. $3\frac{1}{2} + 4\frac{1}{3} - \frac{5}{6}$ of $\frac{3}{4}$.
9. $2\frac{1}{2}$ of $3\frac{1}{3} - 1\frac{1}{2} + \frac{3}{5}$ of $\frac{2}{3}$. 10. $3\frac{2}{7}$ of $4\frac{4}{7} \div 5\frac{5}{7} - 2\frac{2}{7}$.
11. $\frac{3}{4}$ of $4\frac{1}{4} + \frac{7}{8} \div 1\frac{5}{12} - \frac{2}{3}$. 12. $3\frac{1}{4} \div 4\frac{1}{2}$ of $\frac{7}{8} + \frac{1}{4}$.
13. $\frac{3}{4} + \frac{2}{5}$ of $\frac{1}{7} \div \frac{1}{8}$ of $\frac{3}{14}$. 14. $\frac{3}{4} \div 1\frac{1}{2} \times 2\frac{1}{3} - \frac{1}{2}$ of $\frac{1}{3}$.
15. $\frac{2}{3}$ of $1\frac{1}{5} - \frac{1}{5}$ of $\frac{1}{3} - \frac{1}{3} \div 5$. 16. $7\frac{1}{2} + \frac{1}{3} \div \frac{1}{4}$ of $\frac{1}{6} - \frac{3}{2} \times 1\frac{1}{5}$.
17. $1\frac{1}{7}$ of $3\frac{1}{2} + \frac{4}{13}$ of $3\frac{3}{4}$ of $3\frac{1}{4} \div 4\frac{1}{2}$ of $\frac{7}{8} - 1\frac{3}{4} \times \frac{3}{14}$.
18. $4\frac{4}{7} + 5\frac{5}{7} \div 8 - 20\frac{1}{4} \times 3\frac{1}{3}$ of $\frac{1}{25} \div \frac{3}{16}$ of $2\frac{2}{3}$.

THE USE OF BRACKETS.

128. When an expression is enclosed in a **bracket** ( ), { } or [ ], or placed under a **vinculum** $\overline{\quad\quad}$, the whole expression is affected by the sign that precedes or follows the bracket or vinculum.

Thus,

2 ÷ (3 + 4) means that 2 is to be divided by the sum of 3 and 4.

$(2+3)\times 4$ means that the sum of 2 and 3 is to be multiplied by 4.

$13-(3+5)$ means that the sum of 3 and 5 is to be subtracted from 13.

$7-(3+\overline{4-2})$ means that the difference between 4 and 2 is to be added to 3, and the result to be subtracted from 7.

Hence to simplify an expression like the above, we are to perform the operations indicated inside the brackets before performing operations indicated outside the brackets.

Note. In a product the sign of multiplication is often omitted when one or more of the factors are enclosed in brackets.

Thus, $3(5-4)$ means $3\times(5-4)$;

$(3+2)(4-2)$ means $(3+2)\times(4-2)$.

129. A bracket may be removed if it is preceded by the sign $+$: thus $8+(7-5+2)=8+7-5+2$.

A bracket preceded by the sign $-$ may also be removed if the sign of every term within the bracket is changed, namely $+$ to $-$ and $-$ to $+$: thus $8-(7-5+2)=8-7+5-2$.

Example. Simplify $7-[\frac{3}{4}+\{2\frac{1}{3}-(1\frac{1}{2}-\frac{1}{3})\}]$.

The expression

(i) $=7-[\frac{3}{4}+\{2\frac{1}{3}-1\frac{1}{2}+\frac{1}{3}\}]$	or (ii) $=7-[\frac{3}{4}+\{2\frac{1}{3}-\frac{7}{6}\}]$
$=7-[\frac{3}{4}+2\frac{1}{3}-1\frac{1}{2}+\frac{1}{3}]$	$=7-[\frac{3}{4}+\frac{7}{6}]$
$=7-\frac{3}{4}-2\frac{1}{3}+1\frac{1}{2}-\frac{1}{3}$	$=7-\frac{25}{12}$
$=$etc.	$=$etc.

EXAMPLES. 81.

Simplify

1. $3-(\frac{1}{3}+1\frac{1}{2})$.
2. $4-(3\frac{1}{2}-\frac{3}{4})$.
3. $(3-1\frac{1}{12})$ of $3\frac{5}{7}$.
4. $(3-1\frac{1}{12})\times 3\frac{5}{7}-1\frac{1}{14}$.
5. $3-1\frac{1}{12}(3\frac{5}{7}-1\frac{1}{14})$.
6. $(3-1\frac{1}{12})(3\frac{5}{7}-1\frac{1}{14})$.
7. $(3+1\frac{1}{12})\div 3\frac{5}{7}-1\frac{1}{14}$.
8. $3+1\frac{1}{12}\div(3\frac{5}{7}-1\frac{1}{14})$.
9. $(3+1\frac{1}{12})\div(3\frac{5}{7}-1\frac{1}{14})$.
10. $7\frac{1}{2}+2\frac{1}{3}\div(\frac{3}{4}\times 1\frac{1}{3})$.
11. $6+\{1\frac{1}{2}+(\frac{3}{4}-\frac{1}{2})\}$.
12. $6-\{1\frac{1}{2}+(\frac{3}{4}-\frac{1}{2})\}$.
13. $6-\{1\frac{1}{2}-(\frac{3}{4}-\frac{1}{2})\}$.
14. $6-\{1\frac{1}{2}-(\frac{3}{4}+\frac{1}{2})\}$.
15. $17\frac{1}{2}-\{8\frac{1}{4}+\frac{3}{4}(2\frac{1}{2}-1\frac{3}{4})\}$.
16. $17\frac{1}{2}-\{8\frac{1}{4}-\frac{3}{4}(2\frac{1}{2}+1\frac{3}{4})\}$.
17. $9\frac{1}{2}-[7\frac{1}{2}+\{4-(5-2)\}]$.
18. $9\frac{1}{2}+[7\frac{1}{2}-\{4+(5-2)\}]$.
19. $3\div[2+3\div\{4+5\div(2-\frac{1}{3})\}]$.
20. $(2-\frac{1}{2}\text{ of }\frac{1}{3})\div(7\frac{1}{2}\div 2\frac{1}{2})$.
21. $5\frac{1}{2}-[2\frac{1}{3}+\{\frac{3}{4}-\frac{1}{2}(\frac{2}{3}-\overline{\frac{1}{6}-\frac{1}{8}})\}]$.
22. $6-[4-\frac{3}{8}\{7\frac{1}{5}-(3\div\overline{2-\frac{1}{2}})\}]$.

129a. *Example.* Simplify

$$\frac{\frac{3}{7}-\frac{2}{9}}{\frac{3}{7}+\frac{2}{9}} \text{ of } 2\frac{11}{26} \div \frac{4}{13-3\frac{8}{9}} + 3\frac{11}{16} - \frac{3}{3-1\frac{10}{13}}.$$

$$\text{The expression } = \frac{27-14}{27+14} \text{ of } \frac{63}{26} \div \frac{4}{9\frac{1}{9}} + 3\frac{11}{16} - \frac{3}{1\frac{3}{13}}$$

$$= \frac{13}{41} \text{ of } \frac{63}{26} \div \frac{4}{\frac{82}{9}} + 3\frac{11}{16} - \frac{3}{\frac{16}{13}}$$

$$= \frac{\cancel{13}}{\cancel{41}} \times \frac{\overset{7}{\cancel{63}}}{\underset{2}{\cancel{26}}} \times \frac{1}{4} \times \frac{\overset{2}{\cancel{82}}}{\cancel{9}} + 3\frac{11}{16} - \frac{3}{1} \times \frac{13}{16}$$

$$= \frac{7}{4} + \frac{59}{16} - \frac{39}{16}$$

$$= \frac{28+59-39}{16}$$

$$= \frac{48}{16}$$

$= 3$. *Ans.*

EXAMPLES. 82.

Simplify

1. $\dfrac{3\frac{1}{4}-2\frac{1}{3} \text{ of } 1\frac{2}{7}-\frac{1}{7}}{(3\frac{1}{4}-2\frac{1}{3}) \text{ of } (1\frac{2}{7}-\frac{1}{7})}$.

2. $\dfrac{7\frac{1}{2}}{6\frac{1}{2}}+\dfrac{11\frac{1}{2}-2\frac{2}{5}}{11\frac{1}{2}+2\frac{2}{5}} \times 10\frac{9}{13}-6\frac{42}{273}$.

3. $\dfrac{2\frac{1}{4}}{2\frac{2}{5}}+\dfrac{2\frac{1}{2}+5\frac{1}{4}}{3\frac{1}{3}+9\frac{1}{2}}+\frac{1}{2}+\frac{2}{3} \text{ of } \frac{3}{20}$.

4. $\dfrac{5\frac{6}{7}-3\frac{3}{4}+4\frac{1}{14}}{3\frac{1}{3}+\dfrac{1+\frac{1}{5}}{2-\frac{5}{6}}}$.

5. $\dfrac{17}{7+\dfrac{3}{4-2\frac{3}{4}}} \times \dfrac{2021}{2193} \div \left(1\frac{37}{48}-\frac{15}{16}\right)+\frac{3}{4} \text{ of } \dfrac{3\frac{1\frac{1}{2}}{2}}{2\frac{1}{3}}$.

6. $\left\{\left(\frac{3}{10}+\frac{4}{5}\right) \times \left(3-\frac{1}{2}\right)\right\} \div \left(\frac{1}{3}+\frac{1}{6}\right)+\dfrac{1}{2+\dfrac{1}{2+\frac{1}{2}}} \text{ of } \frac{3}{4} \text{ of } \frac{5}{6} \div 2$.

7. $\dfrac{3\frac{1}{2}-2\frac{1}{3}}{\frac{1}{4} \text{ of } (\frac{1}{3}+\frac{1}{7})} \div 15\frac{5}{6}$.

8. $\dfrac{1+5\frac{5}{6}(1+5\frac{5}{6})}{1+2\frac{1}{3}(1+2\frac{1}{3})} \text{ of } 3\frac{1}{5}$.

9. $\frac{1}{2}$ of $\frac{1}{3}\times\frac{3}{4}$ of $\frac{4}{5}\div(\frac{7}{6}+\frac{1}{3}$ of $20)$.

10. $\dfrac{\frac{3}{4}\div\frac{3}{4}\text{ of }\frac{3}{4}}{\frac{3}{4}\div\frac{3}{4}\times\frac{3}{4}}$.

11. $\dfrac{1\frac{7}{9}\text{ of }\frac{27}{8}}{1\frac{1}{2}\times 9\frac{9}{11}}\div\dfrac{4\frac{4}{7}\text{ of }\frac{21}{160}}{2\frac{5}{6}\div 2\frac{2}{15}}$.

12. $\dfrac{1}{\frac{1}{2}+\frac{1}{3}+\dfrac{\frac{1}{8}}{\frac{3}{4}-\frac{1}{3}}}$.

13. $\dfrac{6\frac{4}{11}}{6-4\frac{4}{11}}+\frac{5}{9}\times 1\frac{22}{27}$ of $\frac{3}{56}-\dfrac{6+\dfrac{1}{6+\dfrac{1}{6-\frac{1}{6}}}}{6}$.

14. $\dfrac{3+\dfrac{1}{3-\frac{1}{3}}}{5+\dfrac{1}{5-\frac{1}{5}}}\times 7\frac{5}{6}$.

15. $\dfrac{8\frac{7}{8}+7\frac{3}{4}+5\frac{2}{3}-4\frac{1}{3}}{13-11\frac{9}{10}+10\frac{7}{9}-9\frac{5}{6}}$ of $\frac{2}{11}$ of 365.

16. $\left(9-\frac{4}{5}\div\frac{1}{7}\right)^2$.

17. $\dfrac{\frac{1}{24}\text{ of }6\frac{13}{17}\text{ of }24\frac{1}{18}-4\frac{13}{18}\times 3\frac{33}{34}\div 3\frac{37}{68}}{8\frac{1}{19}\times 5\frac{1}{3}\div 4\frac{5}{12}-7\frac{1}{20}\times 5\frac{1}{8}\div 14\frac{2}{25}}\times 4\frac{2}{3}$.

18. $1\frac{5}{8}$ of $\dfrac{\frac{1}{2}+\frac{1}{3}+\frac{1}{4}}{2\frac{1}{2}-3\frac{1}{3}+4\frac{1}{4}}\times\dfrac{\dfrac{2\frac{1}{2}}{3\frac{1}{7}}+\dfrac{1\frac{3}{8}}{1\frac{5}{8}}}{\dfrac{3}{4\frac{1}{2}}+\dfrac{4\frac{1}{2}}{3}}\div 3\frac{2}{3}$ of $\frac{9}{11}$.

19. $\dfrac{14\frac{1}{3}}{32}+\dfrac{5\frac{5}{8}\div\frac{2}{3}}{1\frac{1}{8}\text{ of }\frac{5}{9}\div 10\frac{1}{3}}\times\frac{2}{5}$ of $\dfrac{1\frac{1}{2}\text{ of }4\frac{1}{3}}{13\frac{7}{8}\times 5\frac{1}{3}}$.

20. $\dfrac{1\frac{1}{8}\div 1\frac{1}{8}}{\frac{3}{5}\text{ of }\frac{5}{9}\div 10\frac{1}{3}}\times\dfrac{1\frac{1}{2}\text{ of }4\frac{1}{9}}{5\frac{1}{16}\text{ of }5\frac{1}{3}}$.

21. $\dfrac{\dfrac{2}{1-\frac{1}{8}}+\frac{1}{3}+\frac{1}{7}}{1-\frac{1}{7}\text{ of }\left(\dfrac{\frac{1}{5}}{1-\frac{4}{5}}+\frac{1}{3}\right)}$.

22. $\left\{\dfrac{2}{3-\dfrac{1}{1-\frac{1}{2}}}-\frac{1}{3}\text{ of }\left(5-\dfrac{2}{\frac{3}{2}-\frac{1}{6}}\right)\right\}\div\dfrac{\frac{1}{2}+\frac{5}{4}}{11\frac{1}{2}}$.

23. $\dfrac{7}{5-\frac{3}{8}}\div\dfrac{3-\dfrac{2}{3-\frac{3}{8}}}{4-\frac{3}{2}}-\frac{5}{7}$ of $\left\{\dfrac{1}{1\frac{3}{7}}+\frac{6}{5}\text{ of }\dfrac{3\frac{1}{3}-2\frac{1}{2}}{4\frac{7}{21}-2}\right\}$.

24. $8-8\times\dfrac{2\frac{1}{3}-1\frac{2}{3}}{2-\dfrac{1}{6-\frac{1}{6}}}$.

25. $\dfrac{1+2\frac{1}{2}+3\frac{1}{3}}{\dfrac{1}{1\frac{1}{2}}+\dfrac{2}{2\frac{1}{3}}+\dfrac{3}{3\frac{1}{4}}}\times\dfrac{55\frac{5}{6}\div 11}{1\frac{2}{11}\text{ of }13\frac{3}{8}}$.

26. $\left(\frac{1}{3}+\dfrac{\frac{8}{7}}{1\frac{3}{5}}+1\frac{1}{4}+\frac{5}{6}-1\right)\div\frac{5}{6}$ of $\frac{5}{8}$ of $2\frac{5}{7}$.

27. $\dfrac{\dfrac{2}{2+\dfrac{2}{2+\frac{1}{2}}} \text{ of } \frac{1}{2} \div (1+\frac{1}{2})}{4\left(1+\dfrac{2}{4\frac{1}{2}}\right)-3}$.

28. $1\dfrac{3\frac{1}{2}}{14} \div \frac{3}{5} \text{ of } \dfrac{2\frac{3}{4} \text{ of } 9}{2+\dfrac{4}{6-\dfrac{8}{10+\frac{1}{12}}}}$.

29. $\dfrac{3+\dfrac{1}{3+\dfrac{1}{3+\frac{1}{3}}}}{1\frac{3}{4} \text{ of } \frac{1}{3} \div 3\frac{1}{2}} \text{ of } \dfrac{5}{9} \div \dfrac{\frac{1}{4} \text{ of } \frac{1}{4}}{\frac{1}{2} \text{ of } \dfrac{3}{4-1\frac{3\frac{1}{4}}{5}}}$.

30. $3+3\div\dfrac{3-3 \text{ of } \frac{4}{5} \div 7 \times 3}{1+\frac{1}{2}+3+\frac{1}{3}}$.

31. $\left\{\frac{1}{8} \text{ of } (\frac{1}{10}-\frac{1}{11}) \div \dfrac{\frac{1}{7}-\frac{1}{8}\div(\frac{4}{9}+\frac{34}{11})}{\frac{1}{7}+\frac{1}{9}\div(\frac{4}{9}-\frac{4}{11})}\right\} \times \dfrac{\frac{1}{3}+\frac{1}{7}\div(\frac{1}{7}-\frac{1}{8})}{(\frac{1}{3}+\frac{1}{7})\div\frac{1}{7}-\frac{1}{8}}$.

32. $\dfrac{\frac{5}{8}+\frac{7}{8} \text{ of } \frac{4}{5} \div \frac{3}{4} \text{ of } \frac{9}{10}}{8\frac{1}{3}-\left(\dfrac{4}{1-\frac{7}{8}} \text{ of } 2\frac{1}{4}\right)\div\frac{7}{9} \text{ of } 12} \text{ of } 6\frac{1}{2}+3\frac{1}{9}$.

33. $\dfrac{\left\{\dfrac{\frac{11}{99}+\frac{6}{13}}{1-\frac{11}{99}\times\frac{6}{13}}-\frac{11}{99}\right\}}{1-\frac{11}{99}\left\{\dfrac{\frac{6}{13}+\frac{11}{99}}{1-\frac{11}{99}\times\frac{6}{13}}\right\}}$.

34. $2\frac{1}{2}\div\dfrac{1-\frac{5}{6}}{\frac{1}{3}-\frac{1}{4}}+(\frac{1}{2}+\frac{1}{4})\div\frac{1}{3}+\frac{1}{5}$.

35. $3-\dfrac{1}{2+\dfrac{1}{1-\dfrac{1}{\frac{4}{5}+\frac{2}{3}}}}\times 2+\dfrac{1}{1+\dfrac{1}{2\times\dfrac{1}{1-\frac{3}{8}}}}\times 2\div\dfrac{1}{1-\dfrac{1}{1+\dfrac{1}{1+\frac{1}{8}}}}$.

XXIV. FRACTIONAL MEASURES.

130. *Example* 1. Find the value of $\frac{3}{4}$ of R7. 8*a*. 3*p*.

To multiply the compound quantity by $\frac{3}{4}$, we divide it by 4 and multiply the quotient by 3, thus :

	R.	*a*.	*p*.	
4)	7	8	3	
	1	14	$0\frac{3}{4}$	
			3	
	R5	10	$2\frac{1}{4}$	*Ans.*

N. B. If we have to multiply by $5\frac{3}{4}$, we multiply first by $\frac{3}{4}$ (as in the above example) and then under the result set down the product by

5, and add the two results. If we have to multiply by $6\frac{3}{4}$, *i. e.*, by $\frac{27}{4}$, we divide by 4, and multiply the quotient by 27, using factors.

Note 1. To divide a compound quantity by $\frac{3}{4}$, we divide it by 3 and multiply the quotient by 4.

Example 2 Find the value of $1\frac{1}{3}$ of $1\frac{1}{4}$ of ₹1.

$$1\tfrac{1}{3} \text{ of } 1\tfrac{1}{4} \text{ of ₹}1 = \tfrac{4}{3} \text{ of } \tfrac{5}{4} \text{ of ₹}1 = ₹\tfrac{5}{3} = \frac{₹5}{3}.$$

	₹.	*a.*	*p.*	
3)	5	. 0	. 0	
	₹1	. 10	. 8	*Ans.*

Example 3. Find the value of $\frac{5}{12}$ of £17. 7*s.* 6*d.* + $\frac{2}{3}$ of £5.

$$\tfrac{5}{12} \text{ of } £17 . 7 . 6 = \frac{£17 . 7 . 6}{12} \times 5 = £1 . 8 . 11\tfrac{1}{2} \times 5 = £7 . 4 . 9\tfrac{1}{2};$$

$$\tfrac{2}{3} \text{ of } £5 \quad = £\frac{10}{3} \quad = \frac{£10}{3} \quad = £3 . 6 . 8;$$

$\therefore$ the value required $= £10 . 11 . 5\frac{1}{2}$.

A second form of operation is as follows:

$$\tfrac{5}{12} \text{ of } £17 . 7 . 6 + \tfrac{2}{3} \text{ of } £5 = \frac{£17 . 7 . 6}{12} \times 5 + £\frac{10}{3}$$

$$= £1 . 8 . 11\tfrac{1}{2} \times 5 + \frac{£10}{3}$$

$$= £7 . 4 . 9\tfrac{1}{2} \quad + £3 . 6 . 8$$

$$= £10 . 11s. 5\tfrac{1}{2}d. \quad \textit{Ans.}$$

Note 2. When we have to multiply or divide a compound quantity by a fraction, the terms of which are large numbers, it is generally better to adopt the following method.

Example 4. Find the value of $\frac{311}{550}$ of ₹10. 2*a.* 6*p.*

Process: $\frac{311}{550}$ of ₹10 . 2 . 6 $= \frac{311}{550}$ of 1950*p.*

$= \frac{311 \times 1950}{550}p. = \frac{311 \times 39}{11}p. = \frac{12129}{11}p.$

$= 1102\frac{7}{11}p. = 91a.\ 10\frac{7}{11}p. =$ ₹5. 11*a.* $10\frac{7}{11}p.$ *Ans.*

EXAMPLES. 83.

Find the value of

1. $\frac{2}{3}$ of ₹5. 7*a.* 6*p.*
2. $\frac{5}{6}$ of ₹2.
3. $\frac{3}{4}$ of ₹3. 2*a.*
4. $\frac{4}{9}$ of ₹19. 3*a.* 6*p.*
5. $\frac{3}{8}$ of ₹3. 4*a.*
6. $\frac{5}{8}$ of 12*a.*

7. $\frac{4}{11}$ of £92. 19*s.* 11*d.* **8.** $\frac{5}{8}$ of £70. 4*s.* **9.** $\frac{3}{10}$ of £99.

10. $5\frac{3}{5}$ of R12. 9*a.* 8*p.* **11.** R$\frac{7}{8}$+R$\frac{11}{12}$. **12.** R$2\frac{1}{2}$−R$1\frac{1}{8}$.

13. $4\frac{3}{8}$ of £2. 11*s.* $7\frac{1}{4}$*d.* **14.** $4\frac{4}{15}$ of £9. **15.** $\frac{35}{112}$ of £1.

16. R13. 12*a.* 9*p.* × $3\frac{4}{5}$. **17.** R13. 13*a.* 6*p.* × $1\frac{5}{13}$.

18. £1. 7*s.* 6*d.* × $\frac{27}{38}$. **19.** £10. 10*s.* $10\frac{1}{2}$*d.* × $\frac{278}{189}$.

20. R25. 12*a.* 9*p.* ÷ $\frac{35}{727}$. **21.** £100. 3*s.* $4\frac{3}{4}$*d.* ÷ $2\frac{9}{20}$ of $\frac{9}{5}$.

22. $3\frac{3}{4}$ of 1 cwt. 1 qr. 1 lb. **23.** $2\frac{2}{3}$ of 128 yd. 2 ft. 7 in.

24. $\frac{5}{17}$ of 1 hr. 1 min. 1 sec. **25.** $\frac{4}{21}$ of 3 bus. 2 pk. 1 gall.

26. $3\frac{1}{2}$ of $3\frac{1}{3}$ of R12. 9*a.* 3*p.* **27.** $\frac{1}{4}$ of $\frac{2}{7}$ of $1\frac{1}{3}$ of R7. 3*a.*

28. $2\frac{1}{3}$ of $6\frac{2}{5}$ of R7. 9*a.* 3*p.* ÷ $7\frac{1}{2}$ of R1. 3*a.* 4*p.*

29. $\frac{3}{4}$ of $4\frac{1}{5}$ of £2. 12*s.* 6*d.* − $\frac{5}{24}$ of £1. 6*s.* 6*d.*

30. £$7\frac{21}{45}$ + $\frac{8}{9}$ of 15*s.* + 7*s.* ÷ $\frac{3}{4}$ + $4\frac{2}{7}$ of £3. 3*s.*

31. R$13\frac{1}{8}$ − $3\frac{7}{8}$ of 7*a.* − R2. 4*a.* ÷ $\frac{99}{56}$ + $7\frac{1}{9}$ of R3.

32. $\frac{436}{369}$ of R2. 9*a* + $\frac{117}{456}$ of R7. 8*a.* + $\frac{29}{319}$ of R9. 4*a.*

33. $\frac{3}{4}$ of $\frac{5}{8}$ of £1 + $\frac{2}{3}$ of $\frac{5}{9}$ of 2*s.* 6*d.* + $\frac{3}{4}$ of $10\frac{1}{2}$*d.*

34. $\frac{5}{8}$ of $\frac{7}{9}$ of R1 + $\frac{3}{4}$ of $\frac{5}{7}$ of 3*a.* 9*p.* + $\frac{2}{3}$ of $7\frac{1}{2}$*p.*

35. $\frac{11}{12}$ of £1 + $\frac{3}{4}$ of 2 guineas − $\frac{5}{9}$ of 3*s.* 9*d.* + $\frac{7}{8}$ of 1*s.*

36. $\frac{3}{4}$ of a guinea + $\frac{5}{6}$ of a crown − $\frac{7}{8}$ of 3*s.* 6*d.*

37. $\frac{7}{8}$ of R7. 8*a.* 6*p.* − $\frac{4}{7}$ of 7*a.* 7*p.* + $\frac{2}{3\frac{1}{2}}$ of $\frac{4}{\frac{9}{7}-\frac{2}{9}}$ of R$\frac{5}{8}$.

38. $\frac{2\frac{3}{4}}{7-\frac{1}{8}}$ of R8. 9*a* + $\frac{3\frac{7}{11}}{4\frac{4}{7}}$ of $\frac{10\frac{5}{7}}{7\frac{1}{2}}$ of R9. 0*a.* 7*p.*

39. $(3\frac{1}{2} \div 3\frac{1}{3})$ of £3. 9*s.* $0\frac{3}{4}$*d.* + $(\frac{2}{3})^2$ of 27*s.* − $\frac{7\frac{3}{4}-3\frac{11}{12}}{18\frac{1}{2}\div\frac{3}{7}}$ of 5*s.*

40. Arrange $\frac{3}{4}$ of R7, $\frac{11}{12}$ of R6. 11*a.* and R$\frac{2}{3}$ in order of magnitude.

41. $\frac{3}{7}$ of $1\frac{1}{6}$ of a sum of money is £7. 7*s.* 7*d.*; find the sum.

42. What is the sum, $\frac{5}{12}$ of which is R3. 9*a.* 3*p.*?

43. From $\frac{3}{8}$ of a certain sum of money when $\frac{4}{5}$ of R3. 7*a.* is subtracted the remainder is R1. 1*a.* 1*p.*; find the sum.

44. Find the value of $\frac{1\frac{1}{4}\div 1\frac{1}{7}}{\frac{3}{8}\text{ of }\frac{5}{9}\div 10\frac{1}{3}}$ of $\frac{1\frac{1}{4}\text{ of }4\frac{1}{2}}{6\frac{1}{16}\times 5\frac{1}{4}}$ of R50.

45. Simplify $\frac{3\frac{1\frac{9}{14}}{4}}{20}$ of £1 + $1\frac{4}{39}$ of $\frac{1}{1+\frac{1}{9+\frac{3}{4}}}$ of 15*s.* + $\frac{5-\frac{1}{4}}{12}$*s.*

131. To express one quantity as the *fraction* of another.

Example 1. Express 13*a*. 4*p*. as the fraction of ₨1.

The fraction $=\dfrac{13a.\ 4p.}{₨1}=\dfrac{13\frac{1}{3}}{16}=\dfrac{40}{48}=\dfrac{5}{6}$.

Note 1. ₨7. 13*a*. 4*p*. $=₨7\dfrac{13a.\ 4p.}{₨1}=₨7\dfrac{13\frac{1}{3}}{16}=₨7\frac{5}{6}$.

Example 2. Express ₨2. 1*a*. 10*p*. as the fraction of ₨3. 2*a*. 9*p*.

The fraction $=\dfrac{₨2.\ 1a.\ 10p.}{₨3.\ 2a.\ 9p.}=\dfrac{406}{609}=\dfrac{2}{3}$.

Example 3. Express $\frac{2}{3}$ of ₨2. 3*a*. as the fraction of $\frac{3}{4}$ of ₨8. 9*a*.

The fraction $=\dfrac{\frac{2}{3}\text{ of ₨2. }3a.}{\frac{3}{4}\text{ of ₨8. }9a.}=\dfrac{\frac{2}{3}\times 35}{\frac{3}{4}\times 137}=\dfrac{2\times 35\times 4}{3\times 137\times 3}=\dfrac{280}{1233}$.

Note 2. The above questions may be put in any of the following forms :

(1) Express ₨2 as the fraction of ₨5.

(2) Reduce ₨2 to the fraction of ₨5.

(3) What part is ₨2 of ₨5 ?

(4) What fraction is ₨2 of ₨5 ?

(5) How many times is ₨5 contained in ₨2 ?

(6) What is the measure of ₨2 when the unit is ₨5 ?

(7) Express ₨2 in terms of ₨5 as unit.

Example 4. Reduce $\frac{2}{3}$ of ₨5 + $\frac{3}{4}$ of ₨2. 3*a*. to the fraction of ₨11. 15*a*.

The fraction $=\dfrac{\frac{2}{3}\text{ of ₨5}+\frac{3}{4}\text{ of ₨2. }3a.}{₨11.\ 15a.}=\dfrac{\frac{2}{3}\times 80+\frac{3}{4}\times 35}{191}$

$=\dfrac{2\times 80\times 4+3\times 35\times 3}{191\times 12}=\dfrac{955}{191\times 12}=\dfrac{5}{12}$.

EXAMPLES. 84.

1. Express ₨3. 4*a*. as the fraction of ₨1.

2. Express 9*a*. 9*p*. as the fraction of 1*a*.

3. Express ₨5. 5*a*. as the fraction of its *highest* denomination.

4. Express 7*s*. 6*d*. as the fraction of its *highest* denomination.

5. Express £7. 10*s*. 6*d*. *in pounds*.

6. Express 7*s*. 4½*d*. *in shillings*.

7. Reduce R7. 5*a*. 4*p*. to the fraction of R1.

8. Reduce £3. 6*s*. 8*d*. to the fraction of £1.

9. Reduce 8*a*. 9*p*. to the fraction of R3. 10*a*. 8*p*.

10. Reduce 12*s*. $5\frac{1}{2}$*d*. to the fraction of £1. 3*s*. 4*d*.

11. What part is R9. 3*a*. 4*p*. of R10. 6*a*. 4*p*.?

12. What part is 27 lb. 12 oz. 15 dr. of 3 cwt. 3 qr. 21 lb.?

13. What part of 1 md. 38 seers is 7 seers 5 ch.?

14. What part of 6 mi. is 2 mi. 441 yd. 1 ft.?

15. What fraction is 12*s*. $10\frac{1}{2}$*d*. of £10.?

16. What fraction is 5 gall. 2 qt. 1 pt. of 10 gall. 2 qt. 1 pt.?

17. What fraction of a guinea is 7*s*. $6\frac{3}{4}$*d*.?

18. What fraction of a ton is 12 lb. 12 oz.?

19. How many times is R7. 8*a*. $4\frac{1}{2}$*p*. contained in R6. 8*a*.?

20. How many times is 3 da. 7 hr. 8 min. contained in 8 da. 7 hr. 3 min.?

21. What fraction is 13*s*. $10\frac{1}{2}\frac{2}{3}$*d*. of £2. 9*s*. 7*d*.?

22. What fraction is $5\frac{1}{2}$ guineas of £$10\frac{1}{2}$?

23. What fraction of $2\frac{1}{2}$ yd. is $2\frac{1}{2}$ ft.?

24. How many times does 8 lb 10 oz. 19 dwt. 9 gr. contain 1 lb. Troy?

25. Express R20. 7*a*. 9*p*. as the fraction of 7*a*. 9*p*.

26. Express £20. 7*s*. 9*d*. as the fraction of 7*s*. 9*d*.

27. Express $\frac{3}{4}$ of R2. 7*a*. 3*p*. as the fraction of R7.

28. Express $1\frac{3}{4}$ of R8 as the fraction of R10. 10*a*. 10*p*.

29. Express $\frac{7}{8}$ of [illegible] 2*d*. as the fraction of £9. 7*s*. 6*d*.

30. Reduce $\frac{5}{8}$ of 1*s*. [illegible]*d*. to the fraction of a crown.

31. Reduce $\frac{11}{12}$ of 8*s*. 9*d*. to the fraction of £3.

32. Reduce $\frac{7}{12}$ of R7. 9*a*. to the fraction of R9. 7*a*. 8*p*.

33. Express $\frac{3}{7}$ of R2. 3*a*. as the fraction of $1\frac{1}{2}$ of R5.

34. Express $3\frac{1}{3}$ of R1. 9*a*. as the fraction of $\frac{15}{16}$ of R7. 8*a*.

35. Reduce $\frac{3}{4}$ of $1\frac{1}{3}$ of 1*s*. 7*d*. to the fraction of $\frac{1}{3}$ of a guinea.

36. Reduce $\frac{3}{5}$ of $\frac{3}{4}$ of R10. 10*a*. 10*p*. to the fraction of $1\frac{1}{6}$ of R5.

37. What part of $1\frac{1}{8}$ of 3 md. 19 seers 8 ch. is 18 seers 7 ch.?

38. What part of $\frac{3}{8}$ of 7 cwt. 7 lb. is $\frac{5}{7}$ of a stone?

39. What fraction of $2\frac{1}{2}$ of $\frac{1}{7}$ of 2 tons is $\frac{3}{8}$ of 3 cwt. 2 lb.?

40. What fraction of a furlong is $\frac{3}{8}$ of $7\frac{1}{2}$ of $16\frac{1}{2}$ yards?

41. How many times is $\frac{3}{5}$ of 7 lb. 7 oz. 7 dr. contained in $\frac{5}{8}$ of a quarter ?

42. What fraction of $\frac{5}{11}$ of a foot is a pole ?

43. What fraction is $\frac{3}{4}$ of a gallon of $\frac{2}{3}$ of a pint ?

44. Express $\frac{3}{7}$ of 1 hr. 15 min. as the fraction of 1 day.

45. Express 5 fathoms as the fraction of $\frac{3}{14}$ of $3\frac{1}{2}$ of a pole.

46. What fraction of $\dfrac{7\frac{4}{5}}{4\frac{3}{5}}$ of £30. 13s. $2\frac{3}{4}d.$ is $(8\frac{4}{7} - 3\frac{2}{5})$ of £5. 9s. $11\frac{1}{2}d.$?

47. Express R$7\frac{3}{4} - \frac{3}{4}$ of R5 as the fraction of R10. 9a.

48. Reduce $\frac{7}{12}s. - \frac{7}{12}d.$ to the fraction of 12s. 10d.

49. Reduce R$7\frac{4}{5} - \frac{1}{5}$ of R7 to the fraction of R5.

50. Express $\frac{7}{8}$ of £1 − $\frac{2}{3}$ of 21s. as the fraction of 10s. 6d.

51. Express $\frac{3}{8}$ of 12s. 6d. + $\frac{3}{4}$ of 16s. 6d. as the fraction of £1.

52. Express $\frac{4}{13}$ of £1. 10s. + $\frac{5}{8}$ of 5s. 4d. − $8\frac{1}{2}$ of $\dfrac{1}{4\frac{1}{4}}$ of 5s. $3\frac{3}{4}d.$ as the fraction of 2s. $1\frac{1}{2}d.$

53. What fraction of $\frac{2}{3}$ of 27s is $\dfrac{3\frac{1}{2}}{4\frac{1}{2}}$ of { $\frac{3}{4}$ of £1 − $\frac{3}{7}$ of 5s. } ?

MISCELLANEOUS EXAMPLES. 83.

1. Express the difference between the greatest and least of the fractions, $\frac{7}{24}$, $\frac{3}{14}$ and $\frac{11}{63}$ as the fraction of the other.

2. A clerk commenced work at a salary of R50 a month, which was each month increased by $\frac{1}{8}$ of that of the preceding month ; what was his third month's salary ?

3. *A* gives away $\frac{2}{3}$ of R50. He gives $\frac{1}{4}$ of this to *B*, $\frac{4}{9}$ of it to *C*, and the remainder to *D*. How much does each get ?

4. A sum of money is divided among 3 men. If the first has $\frac{1}{5}$ of it, the second $\frac{7}{18}$, and the third the remainder which is £2. 7s. $4\frac{1}{2}d.$, what is the entire sum divided ?

5. *A* has R14. 7a. $4\frac{1}{2}p.$, and has $3\frac{3}{4}$ times as much as *B* ; what has *B* ?

6. A person owes a guinea to each of 3 creditors ; to one he pays $\frac{1}{2}$ of his debt, to another $\frac{3}{4}$ and to the third $\frac{4}{5}$; what sum will he be still owing altogether ?

7. After taking out of a purse $\frac{2}{5}$ of its contents, $\frac{2}{3}$ of the remainder were found to be 13s. $5\frac{1}{2}d.$; what sum did the purse contain at first ?

8. A post is divided into 3 parts; the first part is $\frac{1}{4}$ of the whole length, the second $\frac{2}{3}$ of the first, and the third is 3 ft. 6 in. find the length of the post.

9. Five brothers join in paying a sum of money; the eldest pays $\frac{1}{3}$ of it, and the others pay the remainder in equal shares, and thereby each of them pays R20. 7*a*. $7\frac{1}{2}$*p*. less than the eldest brother: what is the sum of money?

10. Find the sum of money that shall be the same part of £3. 10*s*. that 2 lb. 3 oz. avoir. is of 3 lb. 2 oz.

11. What is the sum of money which is the same fraction of R2. 1*a*. that 7 yd. 1 ft. is of 11 yd.?

12. What fraction of R1. 13*a*. 7*p*. must be added to $\frac{3\frac{1}{2}}{2\frac{1}{3}}$ of $(\frac{3}{4}+$ [illegible]$)$ of 1*a*. 4*p*. to make the sum equal to R1?

13. If the American dollar be equal to £$\frac{9}{40}$, what fraction is [illegible] of a dollar of $\frac{2}{7}$ of a guinea?

14. Reduce the difference between 1 lb. avoir. and 1 lb. troy to the fraction of $\frac{3}{5}$ of 1 lb. avoir.

15. Reduce the sum of $\frac{3}{4}$ of £1, $\frac{2}{3}$ of 1*s*. and $\frac{3}{4}$ of 1*d*. to the fraction of $\frac{3}{4}$ of a guinea.

16. A cask contains 35 gall. 2 qt. 1 pt. of wine: what part of it must be taken out to fill 5 quart bottles?

17. Find the greatest sum of money which is contained in each of $\frac{2}{3}$ of R3. 5*a*. 4*p*., $\frac{3}{4}$ of R7. 9*a*. 8*p*. and $\frac{5}{7}$ of 8*a*. 9*p*. a whole number of times.

18. Find the least sum of money that contains each of $\frac{5}{8}$ of R1. 3*a*. 3*p*., $\frac{4}{5}$ of R2. 8*a*. and $\frac{3}{4}$ of R7. 9*a*. 6*p*. an integral number of times.

19. A sum of money increased by its fifth part amounts to R3. 15*a*; what is the sum?

20. What part of 5 units is $\frac{3}{8}$ of a unit?

21. Standard silver is coined at the rate of R2. 6*a*. $10\frac{2}{3}$*p*. per ounce; find the least integral number of ounces that can be coined into an exact number of rupees.

22. Find the least integral number of pounds avoir. that contains an exact number of ounces avoir. and of ounces troy.

23. From a rope 30 ft. long, as many pieces as possible are cut off, each $3\frac{1}{3}$ ft. long: what fraction of the whole will be left?

XXV. DECIMALS.

132. In the ordinary system of notation the value of figure *decreases ten-fold* at each step of removal from left to right; thus, if a certain figure represents hundreds, the next figure to the right

will represent tens ; and the next units. If by a natural extension of this system of notation we place figures to the right of the units' figure, the figure immediately to the right of it will represent *tenths*, the next figure will represent *hundredths*, the next *thousandths*, and so on. Thus

etc.	tens.	units.	tenths.	hundredths.	thousandths.	ten-thousandths.	etc.
	2	1	2	3	4	5	

The number indicated is "twenty one and two tenths, three hundredths, four thousandths, five ten-thousandths."

But in such a system of notation it is necessary to indicate clearly the position of the units' figure; and it has been agreed that the figure to whose right a point (.), called the **decimal point**, is placed shall be the units' figure ; and to distinguish this point from the one used as the sign of multiplication, it is placed towards the top of the figure.

Thus 74·256 represents 74 units, 2 tenths, 5 hundredths, and 6 thousandths ; and is read "*seventy-four* **decimal**, *two, five, six*."

74·056 represents 74 units, no tenths, 5 hundredths, and 6 thousandths ; and is read "seventy-four *decimal*, zero, five, six."

0·205 or ·205 represents no units, 2 tenths, no hundredths, and 5 thousandths ; and is read "*decimal*, two, zero, five."

133. A number expressed in the above notation is called a **decimal** or a **decimal fraction.** The part to the left of the point is called the **integral part,** and the part to the right is called the **decimal part** of the given number.

Note. Such numbers are called decimal fractions because each figure to the right of the decimal point represents a fraction which has some power of 10 as its denominator : thus $2·34 = 2 + \frac{3}{10} + \frac{4}{100}$.

134. The value of a decimal is not altered by annexing ciphers to the right of the last figure ; thus, 2·35 = 2·350 = 2·3500 ; for these ciphers do not alter the position of any of the other figures relatively to the decimal point.

Note. An integer may be expressed as a decimal by writing ciphers in the decimal part; thus $12 = 12 \cdot 00$.

But the value of the *decimal part* of a number decreases ten-fold, a hundred-fold,......, as we place one, two,......, zeros immediately to the right of the decimal point.

Thus $\cdot 1$ is one-tenth;
$\cdot 01$ is one-hundredth;
$\cdot 001$ is one-thousandth;
and so on.

135. It will be observed that a decimal is multiplied by 10, 100, 1000,........, by removing the decimal point 1, 2, 3,......, places to the right; and conversely, a decimal is divided by 10, 100, 1000, ..., by removing the point 1, 2, 3,........, places to the left.

Thus $20 \cdot 31 = 2 \cdot 031 \times 10$

$= 203 \cdot 1 \div 10$

EXAMPLES. 86.

Express as decimals:

1. Three tenths. **2.** Two and one hundredth.

3. Seven hundredths. **4.** One tenth and four thousandths.

5. Eight ten-thousandths. **6.** Nine millionths.

7. Twelve and four hundredths and six hundred-thousandths.

8. One hundredth and three thousandths and five millionths.

9. One ten-thousandth and one hundred-millionth.

10. One hundred and five tenths and two thousandths.

Multiply and divide each of the following numbers by 10, and by 1000;

11. 7. **12.** 29. **13.** $\cdot 2$. **14.** $\cdot 02$.

15. $3 \cdot 4$. **16.** $7 \cdot 03$. **17.** $1 \cdot 003$. **18.** $\cdot 007$.

19. $39 \cdot 2$. **20.** $23 \cdot 45$. **21.** 3000. **22.** $123 \cdot 2$

23. Write down the number which is ten-thousand times $\cdot 0001$.

24. Write down the number which is a millionth part of 10000.

25. How many tenths of an inch are there in $3 \cdot 5$, $7 \cdot 05$ and 4 inches respectively?

26. How many tens-of-inches are there in $2 \cdot 5$, $\cdot 6$ and 3 inches respectively?

136. To convert a decimal into the equivalent vulgar fraction.

Example. Express ·71 and 2·017 as vulgar fractions.

By the preceding Art., we have,

(i) $\cdot 71 = 71 \div 100 = \frac{71}{100}$;

(ii) $2\cdot 017 = 2017 \div 1000 = \frac{2017}{1000}$:

or, $2\cdot 017 = 2 + \cdot 017 = 2 + 17 \div 1000 = 2\frac{17}{1000} = \frac{2017}{1000}$.

Hence the rule: Write down the given number suppressing the decimal point for the numerator, and for the denominator write 1 followed by as many zeros as there are figures in the decimal part.

137. To convert a vulgar fraction having some power of 10 as its denominator, into the equivalent decimal.

Example. Express $\frac{12}{10}$, $\frac{12}{100}$ and $\frac{12}{1000}$ as decimals.

(i) $\frac{12}{10} = 12 \div 10 = 1\cdot 2$.

(ii) $\frac{12}{100} = 12 \div 100 = \cdot 12$.

(iii) $\frac{12}{1000} = 12 \div 1000 = \cdot 012$.

Hence the rule: Take the numerator and in it place the decimal point after as many figures (counting from the right) as there are zeros in the denominator. If the number of figures in the numerator be less than the number of zeros in the denominator prefix in the numerator the requisite number of zeros.

EXAMPLES. 87.

Express as vulgar fractions in their lowest terms:

1. ·4.	**2.** ·83.	**3.** ·04.	**4.** 1·5.
5. ·074.	**6.** ·0125.	**7.** ·0025.	**8.** ·075.
9. 2·88.	**10.** ·725.	**11.** 4·00256.	**12.** 7·225.
13. ·625.	**14.** ·0625.	**15.** 1·11.	**16.** ·0006875.
17. 81·0005.	**18.** 6·4375.	**19.** 5·0096875.	**20.** 70·00004.

Express as mixed numbers with the fractional parts in their lowest terms:

21. 2·5.	**22.** 7·25.	**23.** 8·125.	**24.** 1·75.
25. 2·025.	**26.** 3·05.	**27.** 9·0125.	**28.** 6·0075.
29. 3·0005.	**30.** 7·0675.	**31.** 12·225.	**32.** 11·1.
33. 2·0001.	**34.** 1·2221875.	**35.** 1·0007425.	**36.** 12·0805664062 5

Express the following vulgar fractions as decimals:

37. $\frac{7}{10}$.	**38.** $\frac{30}{100}$.	**39.** $\frac{110}{10}$.	**40.** $\frac{142}{100}$.

41. $\frac{3}{1000}$. **42.** $\frac{7250}{100000}$. **43.** $\frac{329}{10000}$. **44.** $\frac{800}{10000}$.
45. $\frac{12345}{10000}$. **46.** $\frac{70}{10000}$. **47.** $\frac{200030}{1000}$. **48.** $\frac{1008}{100000}$.
49. 125 ten-thousandths. **50.** 790 millionths.

138. The operations of addition, subtraction, multiplication and division of decimals are performed exactly in the same way as in the case of whole numbers. Hence it is an advantage to use decimals in preference to vulgar fractions.

139. Addition of Decimals.

Example. Add together 72·305, 7·06 and ·7896.

We set down the decimals one under another, point under point; thus

```
72·305
 7·06
  ·7896
80·1546   Ans.
```

We then add as in the case of whole numbers, taking care to place the decimal point in the sum under the column of points.

EXAMPLES. 88.

Add together

1. 3·12, 12·023, ·32, 4·7.
2. ·01, 30, 7·469.
3. 39·007, ·0008, 3, 1·3022.
4. 1·3, ·025, 79, ·005.
5. 1·23, 2·345, 6·7891, ·00001.
6. ·04, ·004, ·93, ·026.
7. 4·07, ·089, 2·7012, 3·1398.
8. ·0009, 900, 9·909.
9. 3·3, 10·70902, ·004, ·4, ·12.
10. 7, ·892, ·01, ·098.
11. 700 + 32·7269 + ·00903 + 3·4 + 263·86407.
12. ·1 + ·00095 + 84·0563 + 7·3 + 325·65432.
13. 6·3 + 617·241 + ·0078 + 37·045 + 8·6943 + ·01.
14. ·74259 + 346·274 + 300 + 10·00001 + ·207.
15. ·0705 + 705 + 7·05 + 20·00007 + ·01 + ·00043.
16. R40·004 + R7·2007 + R·00008 + R300·03.
17. £7·54812 + £39·407 + £·07078 + £700.
18. 30 min. + ·0045 min. + 7·7089 min. + 3·7685 min.
19. 329 ft. + ·01 ft. + 3·1 ft. + ·057 ft. + ·308 ft.
20. 2·2 in. + 30·03 in. + ·369 in. + ·7072 in. + 8·0008 in.

140. Subtraction of Decimals.

Example. Subtract 3·587 from 16·29.

We arrange the numbers as in the case of addition ; thus

$$\begin{array}{r} 16{\cdot}29 \\ 3{\cdot}587 \\ \hline 12{\cdot}703 \end{array} \quad \textit{Ans.}$$

We then subtract as in the case of whole numbers, supposing a zero (or more where necessary) annexed to the right of the minuend, and taking care to place the decimal point in the remainder under the column of points.

EXAMPLES. 89.

Subtract

1. 37·039 from 44·123.
2. 7·0389 from 9·01.
3. ·00078 from 1·1.
4. 100·389 from 300·09234.
5. 37·35 from 100.
6. 102 from 306·103.
7. ·000725 from ·001.
8. ·001234 from ·012.
9. ·12345 from 7·6789123.
10. 3·1705 from 345·9875.
11. 7·325 from 8·025.
12. ·9375 from 3·0005.
13. R1·9999 from R9.
14. £32·00051 from £33.

Find the value of

15. 3·789 + 7·002 − ·0079 + ·1 − 1·00001.
16. 700 − ·007 − ·7078 − 3·12345 + ·00025.
17. 100 − ·0072 − 3·9545 − 12 − ·1.
18. 2000 − (·079 + 3·67002 − 3·0012).
19. 1·345 − ·072 − (3·123 − 30·321) + 100.
20. Is 3·1415926535 more accurately represented by 3·14159 or by 3·1416 ?
21. Is 2·718281828 more accurately represented by 2·7182 or by 2·7183 ?

141. Multiplication of Decimals.

If we take *any* two decimals, convert them into vulgar fractions and multiply these latter together, we find that the numerator of the product is the product of the two given decimals with their decimal points suppressed, and that the denominator is 1 followed

by as many ciphers as there are decimal places in the two given numbers; and if now the product be reduced back to the equivalent decimal, it will contain as many decimal places as there are ciphers in the denominator. Hence we have the following rule for the Multiplication of Decimals:

Multiply the given numbers as if they were integers, and mark off in the product a number of decimal places equal to the sum of the numbers of decimal places in the two factors. If the number of figures in the product be less than the number of decimal places in the two factors, prefix the requisite number of ciphers.

Example. Multiply 13·325 by 3·2 and ·00046 by 36.

(i)		(ii)	
	13·325		·00046
	3·2		36
	26650		276
	39975		138
	42·6400 = 42·64 *Ans.*		·01656 *Ans.*

EXAMPLES. 90.

Multiply

1. 32·4 by 2·3.
2. 7·24 by 5.
3. 67·23 by ·002.
4. 30·03 by 200.
5. ·032 by ·032.
6. ·045 by ·0072.
7. 800·008 by ·035.
8. 34·12345 by 72.
9. ·0202 by 2020.
10. 4030·4 by ·0075.
11. 4·379 by ·37.
12. ·00125 by ·25.
13. 10·607 by 402000.
14. ·000625 by 12800.
15. 725 by ·0008.
16. 6400 by ·00125.
17. 5·12 by 42·25.
18. 46·025 by 12·8.
19. ·0064 by ·0125.
20. ·00846 by ·005.
21. ·007853 by ·00476.
22. 56·875 by ·0144.
23. ·015625 by ·0064.
24. ·0204 by 40·2.
25. 700 by ·005.
26. 79·235 by 39·02.
27. 40·25 by 30·04.
28. 12·8 by ·0075.
29. 1·12005 by ·12005.
30. 9·006 by 5·40005.
31. 2·5 × 2·5 × 2·5.
32. ·25 × ·25 × ·25.
33. ·05 × ·08 × ·02.
34. 1·2 × 15 × ·12.
35. 11 × 1·1 × ·11.
36. 20 × ·2 × ·25.
37. ·0005 × ·005 × ·05.
38. 7 × ·7 × ·07 × 7000.
39. ·3 × ·03 × ·003 × 30.
40. 2000 × ·0055 × 2·5.

Find the value of

41. $(6{\cdot}25)^2 - ({\cdot}5)^2$.
42. (74·5 − ·007) × ·035.
43. 7·6 − 3·7 × ·009.
44. $({\cdot}05)^2 + 4{\cdot}5 \times$ [illegible]
45. $7{\cdot}5 \times {\cdot}75 - {\cdot}75 \times {\cdot}075 + (7{\cdot}5)^2 - (7{\cdot}5 - {\cdot}75) \times {\cdot}075$.

142. Division of Decimals.

I. *When the Divisor is an Integer.*

Example 1. Divide 808·9 by 25.

Process :

```
25 ) 808·9 ( 32·356   Ans.
     75
      58
      50
       89
       75
       140
       125
        150
        150
```

Here we divide as in the case of whole numbers, taking care to place the decimal point in the quotient as soon as the division of the integral part is finished.

If there is a remainder (as in the above case) after division, we affix a zero to the remainder, and divide. We treat all successive remainders in the same manner, and continue the division until the required number of decimal places in the quotient is obtained, or until there is no remainder.

Note. The method of short division may be employed with advantage when the divisor does not exceed 20, or when the divisor can be expressed as the product of factors each less than 20.

Example 2. Obtain the quotient to five places of decimals in the division of ·025 by 7.

Process :

```
7 ) ·025
    ·00357...   Ans.
```

II. *When the Divisor is a decimal:*

Remove the decimal point in both the Divisor and Dividend as many places to the right as will make the *divisor* a whole number; and then divide as in the preceding case.

Note. Observe that removing the decimal point in the divisor and dividend an equal number of places to the right is equivalent to multiplying the divisor and dividend by the same number; and that if the divisor and dividend be both multiplied by the same number the quotient is not altered.

Example 3. Divide 12·96 by 10·8.

Here we divide 129·6 by 108 :

```
108 ) 1296 ( 1·2  Ans.
      108
      ---
       216
       216
```

Example 4. Divide 34·6 by 8

Here we divide 3460· by 8 :

```
8 ) 3460·
    -----
    432 5   Ans.
```

143. A vulgar fraction may be expressed as a decimal by dividing the numerator by the denominator.

Example. Express $\frac{5}{8}$ as a decimal.

Process :

```
8 ) 5·
   -----
   ·625   Ans.
```

Note. The following results are useful :

$\frac{1}{2} = \cdot 5$; $\frac{1}{4} = \cdot 25$; $\frac{3}{4} = \cdot 75$; $\frac{1}{8} = \cdot 125$.

EXAMPLES. 91.

Divide

1. 29·21 by 23. **2.** 34·3 by 25. **3.** 129·6 by 108.

4. ·03096 by 72. **5.** 457·7 by 230. **6.** ·06227 by 1300.

7. ·04009 by 1520. **8.** 3708 by 360. **9.** ·00281 by 1405.

10. 8357 by 488. **11.** ·001007 by 47500. **12.** 431·376 by 8170.

Divide, finding the quotient as far as the fifth decimal place.

13. 42·5 by 23. **14.** ·0269 by 281. **15.** 197 by 79.

16. ·041326 by 101. **17.** ·0079 by 372. **18.** 312 by 84.

19. 356·5 by 273. **20.** 6·5 by 342. **21.** ·0042 by 121.

Find the quotient, by Short Division, to not more than 6 places of decimals, in the division of

22. 4·125 by 2. **23.** 3·73 by 8. **24.** ·034 by 7.

25. 21·24 by 90. **26.** 134 by 11. **27.** 36·7 by 16.

28. ·04321 by 80. **29.** 8·567 by 13. **30.** ·01 by 6.

Divide

31. ·3125 by ·01. **32.** 8·454 by ·024. **33.** ·5568 by 2·32.

34. 6·33 by ·0025. **35.** 17·28 by ·0144. **36.** 4 by ·00625.

37. ·00281 by 1·405. **38.** 1·77089 by 4·735.

39. ·00005 by ·0000025. **40.** 816 by ·0004.

41. 84·375 by ·00375. **42.** 2874·465 by ·0495.

43. ·830676 by ·000231. **44.** 33·363 by ·00275.

45. 7 by ·0004. **46.** ·0007 by ·0005.

47. 5·625 by ·0000075. **48.** ·0003738028 by ·0476.

Find the quotient to five places of decimals :

49. 3·461 ÷ ·027. **50.** ·3125 ÷ ·06.

51. ·2 ÷ ·006. **52.** ·000753 ÷ ·009.

53. ·000001 ÷ ·0000431. **54.** ·5 ÷ 76·91342.

55. 4000 ÷ 000121. **56.** ·666666 ÷ ·008.

57. ·007 ÷ ·00673. **58.** 4·00654 ÷ 329·265.

Employ Short Division in finding the quotient to not more than 6 places of decimals :

59. 28 ÷ ·08. **60.** 3·76 ÷ ·005. **61.** ·0076 ÷ ·003.

62. ·0101 ÷ ·0016. **63.** ·000012 ÷ ·13. **64.** 229 ÷ ·007.

65. 39·4 ÷ ·007. **66.** 4·767 ÷ ·004. **67.** 13·75 ÷ ·012.

68. ·02 ÷ 1·1. **69.** ·03 ÷ 1·4. **70.** 3·4 ÷ ·009.

Simplify

71. $\frac{\cdot 0075 \times 2\cdot 1}{\cdot 0175}$. **72.** $\frac{1\cdot 18}{\cdot 152} \times \frac{3\cdot 04}{2\cdot 95}$. **73.** $\frac{\cdot 081 \times 5\cdot 7}{1\cdot 71}$.

Convert into decimals :

74. $\frac{1}{2}$. **75.** $\frac{1}{4}$. **76.** $\frac{3}{4}$. **77.** $\frac{1}{8}$. **78.** $\frac{5}{8}$.

79. $1\frac{7}{16}$. **80.** $3\frac{3}{32}$. **81.** $9\frac{21}{64}$. **82.** $3\frac{7}{25}$. **83.** $\frac{401}{75}$.

Express as decimals as far as the fifth decimal place :

84. $\frac{1}{3}$. **85.** $\frac{1}{6}$. **86.** $\frac{2}{7}$. **87.** $\frac{5}{11}$. **88.** $\frac{9}{13}$.

89. $1\frac{4}{9}$. **90.** $7\frac{9}{11}$. **91.** $8\frac{7}{21}$. **92.** $10\frac{10}{23}$. **93.** $\frac{701}{12}$.

Arrange in order of magnitude, by reducing to decimals as far as the fourth decimal place :

94. $\frac{2}{3}, \frac{3}{4}, \frac{4}{5}$. **95.** $\frac{4}{11}, \frac{5}{12}, \frac{7}{14}$. **96.** $\frac{11}{20}, \frac{16}{30}, \frac{21}{40}$.

97. $\frac{5}{16}, \frac{7}{32}, \frac{3}{8}$. **98.** $\frac{7}{30}, \frac{11}{21}, \frac{13}{30}$. **99.** $\frac{3}{4}, \frac{5}{7}, \frac{7}{9}$.

Reduce to decimals :

100. $\frac{4}{5}$ of ·027. **101.** ·025 of $4\frac{1}{2}$.

102. $\frac{1}{2}$ of $\frac{3}{4}$ × 8·36. **103.** $\frac{1}{4}$ of $\frac{1}{10}$ ÷ ·05 of $2\frac{1}{2}$.

144. H. C. F. and L. C. M. of Decimals.

To find the H. C. F. or the L. C. M. of Decimals, affix ciphers (where necessary) so that all the given numbers may have the same number of decimal places; then find the H. C. F. or the L. C. M. of them as if they were integers, and mark off in the result as many decimal places as there are in each of the numbers.

Example. Find the H. C. F. and L. C. M. of 3, 1·2 and ·06.

The given numbers are equivalent to 3·00, 1·20 and ·06.

The H. C. F. of 300, 120 and 6 = 6; their L. C. M. = 600.

∴ The H. C. F. required = ·06;

and the L. C. M. required = 6·00 = 6.

EXAMPLES. 92.

Find the H. C. F. and L. C. M. of

1. 3·75, 7·25.	**2.** 72·12, ·03.	**3.** ·02, ·4, ·008.
4. 1·2, ·24, 6.	**5.** 1·6, ·04, ·005.	**6.** 2·4, ·36, 7·2.
7. ·08, ·002, ·0001.	**8.** 3·9, 6·6, 8·22.	**9.** ·6, ·09, 1·8.
10. ·18, 2·4, 60.	**11.** 20, 2·8, ·25.	**12.** 1·5, ·25, ·075.

XXVI. RECURRING DECIMALS.

145. In the process of reduction of vulgar fractions to decimals, it will be found, in some cases, that the division does not terminate; so that the quotient can be continued without limit.

Example. Reduce $\frac{19}{55}$ to a decimal.

$$55\,)\,\underline{19\cdot\qquad\qquad}$$
$$\cdot3454545\ldots$$

146. We can tell beforehand whether, in any particular case, the division will terminate or not.

Let the fraction be in its lowest terms; then if the prime factors of the denominator are each of them either 2 or 5, the division will terminate; and not otherwise.

Thus

(i) $\frac{7}{80}\left(=\frac{7}{2\times2\times2\times2\times5}\right)$ will produce a terminating decimal.

(ii) $\frac{7}{12}\left(=\frac{7}{2\times2\times3}\right)$ will produce a non-terminating decimal.

EXAMPLES. 93.

State, in each case, whether the equivalent decimal is terminating or non-terminating :

1. $\frac{1}{6}$.	**2.** $\frac{3}{4}$.	**3.** $\frac{7}{8}$.	**4.** $\frac{21}{24}$.	**5.** $\frac{76}{21}$.
6. $2\frac{40}{63}$.	**7.** $\frac{33}{121}$.	**8.** $\frac{12}{170}$.	**9.** $\frac{34}{510}$.	**10.** $\frac{101}{152}$.
11. $3\frac{18}{72}$.	**12.** $\frac{9}{42}$.	**13.** $7\frac{1}{3}$.	**14.** $\frac{73}{96}$.	**15.** $11\frac{10}{15}$.

16. Write down those numbers between 1 and 20, which being denominators of fractions in their lowest terms, will produce non-terminating decimals.

147. In non-terminating decimals, certain digits must recur over and over again.

Consider the fraction $\frac{5}{6}$. In the process of division the only remainders possible are 1, 2, 3, 4, 5 ; consequently, after five steps at most, we must come to a remainder which has occurred before, and therefore from that point we must have a recurrence of the remainders, and therefore of the digits in the quotient.

Example 1. $\frac{2}{3}$ = ·6666666...

Example 2. $\frac{19}{55}$ = ·3454545...

Note. It may be noticed here that division by 3 or 9 gives a period (See Art. 148) of *one* digit ; division by 11, a period of *two* digits ; division by 7 or 13, a period of *six* digits.

148. Decimals in which certain digits recur are called **recurring decimals.**

Note. A recurring decimal is also called a **periodic, repeating** or **circulating** decimal.

The whole body of digits which recur is called the **period.** Thus, in ·6666...the period is 6 ; in ·3454545...the period is 45.

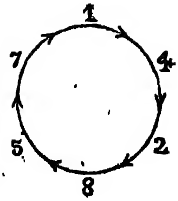
149. In writing a recurring decimal we usually stop at the end of the first period and place dots over its first and last digits.

Thus ·666666......... is written $\cdot\dot{6}$;
·373737......... .... $\cdot\dot{3}\dot{7}$;
·3454545 .... $\cdot 3\dot{4}\dot{5}$;
·34576576...... .... $\cdot 34\dot{5}7\dot{6}$.

A **pure** recurring decimal is one in which the period commences immediately after the decimal point ; as $\cdot\dot{6}$, $\cdot\dot{3}\dot{7}$.

A **mixed** recurring decimal is one in which one or more figures precede the period ; as $\cdot 3\dot{4}\dot{5}$, $\cdot 34\dot{5}7\dot{6}$.

Note. It may be noticed that decimals equivalent to fractions with denominator 7 are all *pure* recurring decimals, all of which contain the same digits 142857. If these digits be arranged in a circle, as in the annexed diagram, we may obtain the decimals equivalent respectively to $\frac{1}{7}$, $\frac{2}{7}$, $\frac{3}{7}$, $\frac{4}{7}$, $\frac{5}{7}$, $\frac{6}{7}$, by beginning in turn with 1, 2, 4, 5, 7, 8, and reading off the remaining digits in order in the direction of the arrow-heads.



Thus $\frac{1}{7} = \cdot\dot{1}4285\dot{7}$; $\frac{2}{7} = \cdot\dot{2}8571\dot{4}$; $\frac{3}{7} = \cdot\dot{4}2857\dot{1}$; and so on.

EXAMPLES. 94.

Express each of the following as a recurring decimal.

1.	$\frac{1}{3}$.	2.	$\frac{2}{9}$.	3.	$\frac{5}{7}$.	4.	$\frac{7}{9}$.	5.	$\frac{13}{11}$.
6.	$\frac{20}{13}$.	7.	$\frac{7}{15}$.	8.	$1\frac{1}{111}$.	9.	$\frac{5}{18}$.	10.	$3\frac{8}{13}$.
11.	$\frac{250}{21}$.	12.	$\frac{1}{22}$.	13.	$\frac{20000}{5291}$.	14.	$\frac{5}{24}$.	15.	$\frac{101}{26}$.
16.	$\frac{202}{27}$.	17.	$5\frac{3}{7}$.	18.	$10\frac{1}{13}$.	19.	$7\frac{2}{15}$.	20.	$9\frac{9}{14}$.
21.	$\frac{503}{505}$.	22.	$\frac{726}{52}$.	23.	$4\frac{45}{56}$.	24.	$\frac{3342}{1025}$.	25.	$5\frac{11}{90}$.
26.	$2 \div 3$.	27.	$46 \div 7$.	28.	$39 \div 22$.	29.	$8 \div 63$.	30.	$44 \div 9$.
31.	$\frac{1}{6}$.	32.	$\frac{1}{66}$.	33.	$\frac{1}{666}$.	34.	$\frac{1}{6666}$.	35.	$\frac{7}{666666}$.
36.	$8\frac{8}{75}$.	37.	$3\frac{24}{175}$.	38.	$\frac{1}{17}$.	39.	$\frac{10}{19}$.	40.	$\frac{2}{23}$.

41.	$1{\cdot}2 \div {\cdot}11$.	42.	$1 \div 10{\cdot}01$.	43.	${\cdot}3 \div {\cdot}13$.	44.	$\frac{{\cdot}2}{{\cdot}07}$.
45.	$\frac{{\cdot}03}{{\cdot}0011}$.	46.	$2 + \frac{{\cdot}3}{1{\cdot}1}$.	47.	$7 + \frac{2}{2{\cdot}3}$.	48.	$1 + \frac{1{\cdot}1}{{\cdot}07}$.
49.	$3 + \frac{4}{1{\cdot}3}$.	50.	$\frac{4\frac{1}{2}}{{\cdot}007}$.	51.	$\frac{3{\cdot}7}{4\frac{1}{2}}$.	52.	$\frac{{\cdot}004}{5\frac{1}{2}}$.

150. In a given recurring decimal, the period may be supposed to begin at any point after the first repeating figure.

Thus $\cdot 3272727\ldots = \cdot 3\dot{2}\dot{7} = \cdot 32\dot{7}\dot{2} = \cdot 327\dot{2}\dot{7} =$ etc.

Again, the number of figures in the period of a recurring decimal may be *doubled*, *trebled*,... without altering the value of the decimal.

Thus $\cdot 3\dot{2}\dot{7} = \cdot 3\dot{2}72\dot{7} = \cdot 3\dot{2}7272\dot{7} =$ etc.

151. Recurring decimals are said to be **similar** when they have the same number of non-recurring figures, and also the same

number of recurring figures. Thus $\cdot\dot{3}$ and $\cdot\dot{6}$ are similar recurring decimals ; $\cdot 3\dot{2}\dot{7}$ and $2\cdot 4\dot{5}\dot{6}$ are similar.

152. Two or more given recurring decimals can always be made similar.

Take the recurring decimals $2\cdot\dot{3}$, $\cdot 2\dot{4}\dot{5}$ and $\cdot 25\dot{7}6\dot{8}$.

Now the highest number of non-recurring decimal places in any of these numbers is 2 ; and the numbers of figures in the periods respectively are 1, 2, 3, the L. C. M. of which is 6. Therefore the given recurring decimals may be made similar by extending each of them to eight places of decimals, the first two places being non-recurring and the last six places being recurring.

Thus
$$2\cdot\dot{3} = 2\cdot 33\dot{3}3333\dot{3}\ ;$$
$$\cdot 2\dot{4}\dot{5} = \cdot 24\dot{5}4545\dot{4}\ ;$$
$$\cdot 25\dot{7}6\dot{8} = \cdot 25\dot{7}6876\dot{8}.$$

EXAMPLES. 95.

In each of the following recurring decimals begin the period at the fourth decimal place :

1. $\cdot 2\dot{3}4\dot{5}$. **2.** $\cdot 34\dot{7}\dot{6}$. **3.** $\cdot\dot{6}\dot{7}$. **4.** $\cdot 23\dot{4}\dot{5}$.

5. $\cdot 00\dot{1}2\dot{3}$. **6.** $\cdot 1\dot{2}34\dot{5}$. **7.** $\cdot\dot{1}23\dot{4}$. **8.** $\cdot 1\dot{2}345\dot{6}$.

9. Extend $\cdot 3\dot{4}$, $\cdot\dot{2}\dot{4}$ and $\cdot 2\dot{6}7\dot{8}$ so that they may have the same number of figures in the period.

10. Extend $\cdot 1\dot{0}\dot{2}$, $\cdot 1\dot{2}3\dot{4}$ and $\cdot\dot{3}76\dot{5}$ so that they may have the same number of recurring figures.

Make the following sets of recurring decimals similar :

11. $\cdot 2\dot{3}$, $\cdot\dot{7}\dot{8}$. **12.** $\cdot 3\dot{4}\dot{5}$, $\cdot\dot{7}\dot{6}$, $\cdot 7\dot{2}$.

13. $\cdot 30\dot{7}$, $\cdot\dot{7}\dot{6}$. **14.** $\cdot 0\dot{7}\dot{6}$, $\cdot\dot{7}$, $\cdot 00\dot{0}12\dot{3}$.

15. $\cdot 23\dot{8}$, $\cdot\dot{1}23\dot{4}$, $\cdot 0\dot{2}\dot{3}$. **16.** $\cdot\dot{3}$, $\cdot\dot{7}\dot{6}$, $\cdot\dot{7}23\dot{0}$.

17. $\cdot\dot{7}$, $\cdot 1\dot{2}\dot{4}$, $\cdot 24\dot{7}2\dot{3}$. **18.** $3\cdot\dot{4}$; $\cdot 2\dot{6}\dot{8}$, $\cdot\dot{1}2\dot{3}$.

19. $3\cdot 40\dot{2}$, $\cdot 78\dot{2}\dot{3}$, $\cdot 3\dot{1}$, **20.** $\cdot 4\dot{2}\dot{3}$, $\cdot\dot{7}\dot{2}$, $\cdot 1\dot{2}0\dot{3}$.

153. To express a recurring decimal as a vulgar fraction.

Example 1. $\cdot\dot{5} = \cdot 55555\ldots$

Now, 10 times $\cdot\dot{5} = 5\cdot 5555\ldots$,

and $\cdot\dot{5} = \cdot 5555\ldots$

Subtracting, 9 times $\cdot\dot{5} = 5$;

$\therefore\ \cdot\dot{5} = \frac{5}{9}$.

Example 2. $\cdot 23\dot{4}\dot{5} = \cdot 23454545\ldots$

Now, 10000 times $\cdot 23\dot{4}\dot{5} = 2345\cdot 4545\ldots$

and 100 times $\cdot 23\dot{4}\dot{5} = 23\cdot 4545\ldots$

Subtracting, 9900 times $\cdot 23\dot{4}\dot{5} = 2345 - 23$;

$\therefore \quad \cdot 23\dot{4}\dot{5} = \frac{2345-23}{9900}$.

Example 3. $3\cdot 6\dot{2} = 3\cdot 622222\ldots$

Now, 100 times $3\cdot 6\dot{2} = 362\cdot 2222\ldots$

and 10 times $3\cdot 6\dot{2} = 36\cdot 2222\ldots$

Subtracting, 90 times $3\cdot 6\dot{2} = 362 - 36$;

$\therefore \quad 3\cdot 6\dot{2} = \frac{362-36}{90}$.

154. Hence we deduce the following rule for reducing a recurring decimal to a vulgar fraction :

For the *numerator* take the integral number formed by all the figures up to the end of the first period, subtracting the integral number formed by the figures (if any) that precede the first period ; for the *denominator* take the number formed by as many nines as there are figures in the period, followed by as many ciphers as there are figures between the decimal point and the first period.

Example 1. Find the vulgar fraction equivalent to $\cdot\dot{3}$.

Process : $\cdot\dot{3} = \frac{3}{9} = \frac{1}{3}$. *Ans.*

Example 2. Reduce $\cdot 4\dot{5}$ to vulgar fraction.

Process : $\cdot 4\dot{5} = \frac{45-4}{90} = \frac{41}{90}$. *Ans.*

Example 3. Express $\cdot 0\dot{4}7\dot{6}$ as a vulgar fraction.

Process : $\cdot 0\dot{4}7\dot{6} = \frac{476-4}{9990} = \frac{472}{9990} = \frac{236}{4995}$. *Ans.*

Example 4. Express $\cdot 00\dot{2}7\dot{1}$ as a vulgar fraction

Process : $\cdot 00\dot{2}7\dot{1} = \frac{271}{99900}$. *Ans.*

Example 5. Express $2\cdot 3\dot{7}$ as an improper fraction.

Process : $2\cdot 3\dot{7} = \frac{237-23}{90} = \frac{214}{90} = \frac{107}{45}$. *Ans.*

Example 6. Express $2\cdot 3\dot{7}$ as a mixed number.

Process : $2\cdot 3\dot{7} = 2 + \cdot 3\dot{7} = 2 + \frac{37-3}{90} = 2 + \frac{17}{45} = 2\frac{17}{45}$. *Ans.*

Note. It follows from the rule that $\cdot\dot{9} = \frac{9}{9} = 1$; similarly $\cdot 0\dot{9} = \cdot 1$ and $\cdot 00\dot{9} = \cdot 01$; and therefore $2\cdot\dot{9} = 3$, $2\cdot 3\dot{9} = 2\cdot 4$, $2\cdot 345\dot{9} = 2\cdot 346$; etc. Also $\cdot\dot{9}\dot{9} = 1$, $\cdot\dot{9}9\dot{9} = 1$, $\cdot 2\dot{9}\dot{9} = \cdot 3$; etc.

Therefore when the recurring part contains the figure 9 *only*, the recurring part should be omitted and the preceding figure increased by unity.

EXAMPLES. 98.

Express as vulgar fractions in their lowest terms :

1.	$\cdot\dot{6}$.	**2.**	$\cdot\dot{1}\dot{8}$.	**3.**	$\cdot\dot{1}4285\dot{7}$.	**4.**	$\cdot\dot{7}6923\dot{0}$.
5.	$\cdot2\dot{7}$.	**6.**	$\cdot27\dot{2}$.	**7.**	$\cdot3\dot{7}\dot{8}$.	**8.**	$\cdot03\dot{2}$.
9.	$\cdot00\dot{7}8\dot{5}$.	**10.**	$\cdot008\dot{2}\dot{3}$.	**11.**	$\cdot0010\dot{6}\dot{4}$.	**12.**	$\cdot0\dot{8}\dot{1}$.
13.	$3\cdot\dot{0}1\dot{3}$.	**14.**	$3\cdot4\dot{3}\dot{2}$.	**15.**	$7\cdot0\dot{2}\dot{8}$	**16.**	$31\cdot00\dot{7}$.
17.	$\cdot5\dot{9}2\dot{5}$.	**18.**	$\cdot0\dot{5}$.	**19.**	$2\cdot\dot{6}1904\dot{7}$.	**20.**	$10\cdot25\dot{6}\dot{7}$.
21.	$\cdot0012\dot{3}$.	**22.**	$\cdot011\dot{3}\dot{6}$.	**23.**	$\cdot00\dot{7}2\dot{9}$.	**24.**	$\cdot38\dot{1}4\dot{8}$.
25.	$\cdot00\dot{6}7\dot{5}$.	**26.**	$\cdot0\dot{2}\dot{4}$.	**27.**	$\cdot\dot{0}37\dot{8}$.	**28.**	$\cdot2\dot{2}7\dot{3}$.
29.	$\cdot00\dot{0}2\dot{5}$.	**30.**	$\cdot100\dot{0}\dot{1}$.	**31.**	$3\cdot0\dot{0}0\dot{7}$.	**32.**	$\cdot02\dot{1}7\dot{7}$.

Reduce to improper fractions in their lowest terms :

33.	$3\cdot\dot{6}$.	**34.**	$7\cdot\dot{1}\dot{8}$.	**35.**	$1\cdot3\dot{4}$.	**36.**	$2\cdot7\dot{6}$.
37.	$1\cdot07\dot{2}$.	**38.**	$3\cdot03\dot{6}$.	**39.**	$10\cdot2\dot{7}\dot{5}$.	**40.**	$4\cdot0\dot{0}8\dot{6}$.
41.	$7\cdot12\dot{3}\dot{0}$.	**42.**	$7\cdot6\dot{5}3\dot{1}$.	**43.**	$20\cdot45\dot{9}0\dot{0}$.	**44.**	$14\cdot0\dot{1}3\dot{1}$.
45.	$10\cdot02\dot{2}\dot{7}$.	**46.**	$13\cdot94\dot{2}3076\dot{9}$.	**47.**	$11\cdot00\dot{1}20\dot{0}$.	**48.**	$100\cdot00\dot{1}0\dot{0}$.

49. Prove that $\frac{1}{9}=\frac{\cdot\dot{1}}{1}=\frac{\cdot\dot{2}}{2}=\frac{\cdot\dot{3}}{3}=\frac{\cdot\dot{4}}{4}=\frac{\cdot\dot{5}}{5}=\frac{\cdot\dot{6}}{6}=\frac{\cdot\dot{7}}{7}=\frac{\cdot\dot{8}}{8}$.

50. Prove that $\frac{1}{11}=\frac{\cdot\dot{0}\dot{9}}{1}=\frac{\cdot\dot{1}\dot{8}}{2}=\frac{\cdot\dot{2}\dot{7}}{3}=\frac{\cdot\dot{3}\dot{6}}{4}=\frac{\cdot\dot{4}\dot{5}}{5}=\frac{\cdot\dot{5}\dot{4}}{6}$.

51. Prove that $\frac{1}{13}=\frac{\cdot\dot{0}7692\dot{3}}{1}=\frac{\cdot\dot{1}5384\dot{6}}{2}=\frac{\cdot\dot{2}3076\dot{9}}{3}=\frac{\cdot\dot{3}0769\dot{2}}{4}$.

52. Prove that $\frac{\cdot\dot{1}0\dot{1}}{1}=\frac{\cdot\dot{2}0\dot{2}}{2}=\frac{\cdot\dot{3}0\dot{3}}{3}=\frac{\cdot\dot{4}0\dot{4}}{4}=\frac{\cdot\dot{5}0\dot{5}}{5}$.

Express as non-recurring decimals :

53.	$\cdot0\dot{9}$.	**54.**	$\cdot367\dot{9}$.	**55.**	$1\cdot6\dot{9}$.	**56.**	$\cdot000\dot{9}$.
57.	$\cdot2\dot{9}\dot{9}$.	**58.**	$3\cdot\dot{9}\dot{9}$.	**59.**	$3\cdot9\dot{9}\dot{9}$.	**60.**	$9\cdot\dot{9}9\dot{9}$.

133. Addition and Subtraction of Recurring Decimals.

Rule for Addition : Make the decimals *similar* : add in the usual way and *increase* the last figure in the result by the figure (if any) carried from the first (to the left) column of the period ; then the sum will be a recurring decimal similar to the summands.

Subtraction is effected in exactly the same way, the only difference being that the last figure in the result in this case is diminished (and not increased) by the figure carried.

Example 1. Add together $2\cdot3\dot{7}\dot{5}$, $\cdot8\dot{1}7\dot{3}$ and $4\cdot31$.

Process :

$$\begin{aligned} 2\cdot3\dot{7}\dot{5} &= 2\cdot37\ \dot{5}7575\dot{7} \\ \cdot8\dot{1}7\dot{3} &= \ \ \cdot81\ \dot{7}3173\dot{1} \\ 4\cdot31 &= 4\cdot31 \\ \hline & \ \ 7\cdot50\ 307488 \\ & \qquad\qquad\quad 1 \\ \hline & \ \ 7\cdot50\ \dot{3}07489\dot{9} \end{aligned}$$ *Ans.*

Example 2. Add together $7\cdot63\dot{4}$ and $\cdot8\dot{5}\dot{2}$.

Process :

$$\begin{aligned} 7\cdot63\dot{4} &= 7\cdot63\ \dot{4}\dot{4} \\ \cdot8\dot{5}\dot{2} &= \ \ \cdot85\ \dot{2}\dot{5} \\ & \ \ 8\cdot48\ \dot{6}\dot{9} \end{aligned}$$ *Ans.*

Example 3. Add together $\cdot76\dot{8}$, $\cdot0\dot{7}$ and $1\cdot0\dot{3}$.

Process :

$$\begin{aligned} \cdot76\dot{8} &= \ \ \cdot76\ \dot{8} \\ \cdot0\dot{7} &= \ \ \cdot07\ \dot{7} \\ 1\cdot0\dot{3} &= 1\cdot03\ \dot{3} \\ \hline & \ \ 1\cdot87\ 8 \\ & \qquad\quad 1 \\ & \ \ 1\cdot87\ \dot{9} = 1\cdot88 \end{aligned}$$ *Ans.*

Example. 4. Subtract $\cdot78\dot{3}7\dot{2}$ from $4\cdot0\dot{7}\dot{1}$.

Process :

$$\begin{aligned} 4\cdot0\dot{7}\dot{1} &= 4\cdot07\ \dot{1}7171\dot{7} \\ \cdot78\dot{3}7\dot{2} &= \ \ \cdot78\ \dot{3}7237\dot{2} \\ \hline & \ \ 3\cdot28\ 799345 \\ & \qquad\qquad\quad 1 \\ \hline & \ \ 3\cdot28\ \dot{7}9934\dot{4} \end{aligned}$$ *Ans.*

Example 5. Subtract $\cdot8\dot{6}\dot{2}$ from $6\cdot74\dot{5}$.

Process :

$$\begin{aligned} 6\cdot74\dot{5} &= 6\cdot74\ \dot{5}\dot{5} \\ \cdot8\dot{6}\dot{2} &= \ \ \cdot86\ \dot{2}\dot{6} \\ \hline & \ \ 5\cdot88\ \dot{2}\dot{9} \end{aligned}$$ *Ans.*

EXAMPLES. 37.

Perform the operations indicated below.

1. $3\cdot7\dot{6} + \cdot\dot{0}\dot{2}$.
2. $\cdot7\dot{8}\dot{9} + \cdot00\dot{3}$.
3. $1\cdot0\dot{4} + 2\cdot0\dot{3} + 8\cdot01\dot{7}$.
4. $3\cdot07\dot{2} + 3\cdot4 + \cdot012\dot{3}$.
5. $3\cdot45 + \cdot\dot{6} + \cdot\dot{7}1\dot{2}$.
6. $\cdot031\dot{2} + \cdot023\dot{1} + \cdot07\dot{6}$.
7. $2\cdot8\dot{2} + \cdot03\dot{4} + \cdot001\dot{4}$.
8. $8\cdot3\dot{1} + \cdot\dot{6} + \cdot00\dot{1}$.

9. $10.0\dot{1} + .000\dot{5} + .\dot{3}$.
10. $7.392 + .3\dot{7} + .23\dot{2}$.
11. $.00\dot{7} + .0\dot{8}\dot{2} + .0\dot{1}2\dot{3}$.
12. $1.12\dot{3} + 3.\dot{7}\dot{6} + .\dot{4}57\dot{6}$.
13. $1.30103 + 9.\dot{7} + 8.\dot{0}9\dot{3}\dot{4}$.
14. $.00\dot{3} + .0\dot{0}\dot{3} + .\dot{0}0\dot{3}$.
15. $1.\dot{3} + .0\dot{2}\dot{3} + .\dot{1}23\dot{4} + 9.7$.
16. $.004 + .\dot{3}\dot{7} + .\dot{2}3\dot{4} + 1.\dot{1}$.
17. $7.31\dot{2}347\dot{6} + 1.5\dot{8}7652\dot{3}$.
18. $.\dot{7}\dot{4} + 3.00\dot{1} + 2.123\dot{4}$.
19. $72 + 3.0\dot{1}2\dot{3} + .00\dot{1}23\dot{4}$.
20. $1.3\dot{4}56\dot{3} + 2.\dot{6}54\dot{3}$.
21. $3.\dot{1}34\dot{7} + 7.0\dot{3}\dot{2} + .0\dot{7} + 1.345 + .00\dot{7}\dot{9}$.
22. $1.3\dot{7}\dot{6} + .23\dot{7}0\dot{2} + .0001 + .\dot{6} + .\dot{3}\dot{7}$.
23. $4.0\dot{3}4\dot{5} + 7.234 + 81 + .0\dot{4}56\dot{7} + .0\dot{3} + .\dot{1}\dot{2}$.
24. $3.7\dot{6} - .00\dot{7}\dot{2}$.
25. $4.1\dot{3}0\dot{2} - 1.0\dot{5}\dot{2}$.
26. $.\dot{4}32\dot{5} - .03\dot{7}6\dot{4}$.
27. $2 - .\dot{7}\dot{6} - .\dot{3}2\dot{1}$.
28. $3.46 - .072\dot{3}\dot{4}$.
29. $3.4\dot{7}6\dot{8} - 1.004$.
30. $7 - .23\dot{4}7\dot{6}$.
31. $.9 - .00\dot{8}\dot{9}$.
32. $9.46\dot{8} - 3.123$.
33. $2.\dot{4}67\dot{9} - .00\dot{3}4\dot{5}$.
34. $1 - .\dot{1}0\dot{2} - .4\dot{6}$.
35. $3.\dot{8}97\dot{2} - .00\dot{3}\dot{4}$.
36. $.\dot{7}28\dot{4} - .0\dot{1}2\dot{3}$.
37. $3.\dot{7}\dot{6} - .\dot{1}234\dot{5}$.
38. $.1\dot{2}34\dot{5} - .000\dot{3}\dot{7}$.
39. $789.07\dot{3}\dot{8} - 18.0003\dot{2}5\dot{6}$.
40. $30 - .376\dot{9}803\dot{4}$.

156. Multiplication and Division of Recurring Decimals.

Rule. Reduce the decimals to vulgar fractions; find the product or quotient as a vulgar fraction and reduce it back to the equivalent decimal. *But in the case of division, if the dividend and divisor are both recurring decimals, it will be generally convenient to make them similar before reducing to vulgar fractions.*

Example 1. Multiply $.\dot{0}\dot{9}$ by $7.\dot{3}$.

$$.\dot{0}\dot{9} \times 7.\dot{3} = \frac{9}{99} \times \frac{73-7}{9} = \frac{1}{11} \times \frac{22}{3} = \frac{2}{3} = .\dot{6}.\quad \textit{Ans.}$$

Example 2. Divide $.\dot{6}$ by $.75$.

$$.\dot{6} \div .75 = \frac{6}{9} \div \frac{75}{100} = \frac{2}{3} \times \frac{4}{3} = \frac{8}{9} = .\dot{8}.\quad \textit{Ans.}$$

Example 3. Divide $.7\dot{3}\dot{2}$ by $.02\dot{7}$.

$$.7\dot{3}\dot{2} \div .02\dot{7} = .7\dot{3}2\dot{3} \div .02\dot{7}\dot{7} = \frac{7250}{9900} \div \frac{275}{9900}$$

$$= \frac{7250}{275} = \frac{290}{11} = 26.\dot{3}\dot{6}.\quad \textit{Ans.}$$

EXAMPLES 98.

Find the value of

1. $.0\dot{3} \times .0\dot{6}$.
2. $4.\dot{8} \times .2\dot{4}$.
3. $.\dot{2}\dot{7} \times 4.\dot{9}\dot{6}$.
4. $.\dot{1}\dot{2} \times 1.\dot{3}$.
5. $2.\dot{4} \times .0\dot{4}$.
6. $7.\dot{6} \times 6.\dot{7}$.
7. $.\dot{3} \div .\dot{6}$.
8. $.3\dot{4} \div .00\dot{3}\dot{4}$.
9. $8.0\dot{4} \div .00\dot{3}\dot{4}$.
10. $.3\dot{4}5\dot{6} \div .22\dot{7}\dot{6}$.
11. $.3\dot{9}\dot{4} \div 1.40\dot{3}$.
12. $.\dot{1}4285\dot{7} \div .\dot{1}\dot{8}$.
13. $.0\dot{8}\dot{1} \div .\dot{3}4\dot{6}$.
14. $.0\dot{2}4\dot{4} \div .\dot{1}\dot{8}$.
15. $.3\dot{1}2\dot{3} \div .\dot{0}04\dot{5}$.

157. Complex Fractions involving Decimals.

Example. Simplify $\dfrac{.\dot{3} \text{ of } \frac{5}{8}}{.5 \times .\dot{1}} + \dfrac{.3\dot{5}}{.0\dot{8}}$.

$$\frac{.\dot{3} \text{ of } \frac{5}{8}}{.5 \times .\dot{1}} + \frac{.3\dot{5}}{.0\dot{8}} = \frac{\frac{1}{3} \times \frac{5}{8}}{\frac{1}{2} \times \frac{1}{9}} + \frac{\frac{32}{90}}{\frac{8}{90}} = \frac{1}{\cancel{3}} \times \frac{5}{\cancel{8}} \times \frac{\cancel{2}}{1} \times \frac{\cancel{9}}{1} + \frac{\overset{4}{\cancel{32}}}{\cancel{90}} \times \frac{\cancel{90}}{\cancel{8}}$$

$$= 5 + 4 = 9. \quad \textit{Ans.}$$

EXAMPLES 99.

Simplify, giving each answer in decimals,

1. $\dfrac{.0075 + 2.1}{.0175}$. 2. $\dfrac{4.255 + .0064}{.00032}$. 3. $\dfrac{.00\dot{3} \times .05}{.0022}$.

4. $\dfrac{6.27 \times 0.5}{(\frac{1}{2} \text{ of } \frac{3}{4}) \times 8.36} \div \dfrac{(\frac{1}{4} \text{ of } \frac{1}{10}) \times (.75 \text{ of } 21.\dot{3})}{(\frac{2}{3} \text{ of } \frac{3}{8}) + 1.\dot{4}}$.

5. $\dfrac{4.\dot{2} - 3.1\dot{4}}{1.3 + 2.10\dot{2}}$ of $\dfrac{1.3 \text{ of } 4}{.37 \text{ of } 8.\dot{8}\dot{1}}$. 6. $\dfrac{1.8\dot{3} + 2.041\dot{6} + .\dot{3} - 3\frac{1}{3}}{1.0025 + .0625 - 1\frac{1}{16}}$.

7. $\dfrac{.12 \text{ of } (.0104 - .002) + .36 \times .002}{.12 \times .12}$.

8. $\dfrac{3.125}{2.16}$ of $\dfrac{.2\dot{4}}{.125} \div \dfrac{2.\dot{2}}{1.5}$ of $\dfrac{187.5}{3.42}$.

9. $\left\{37 + \dfrac{3.7\dot{0}3\dot{7}}{100}\right\} \times .54$. 10. $\dfrac{\frac{5}{8} \text{ of } 1\frac{3}{5} + \frac{1}{7} \times 2.\dot{4}}{3 - (\frac{3}{5} + \frac{47}{10}) \div 2.\dot{3}\dot{6}}$.

11. $\dfrac{.1 \times .1 \times .1 + .01 \times .01 \times .01}{.2 \times .2 \times .2 + .02 \times .02 \times .02}$. 12. $\dfrac{.044 \times 2.1}{.000035} \div \dfrac{3.\dot{0}7692\dot{3}}{2.\dot{3} \times 5.\dot{6}}$

13. $\dfrac{2.8 \text{ of } 2.\dot{2}\dot{7}}{1.\dot{3}\dot{6}} + \left\{\dfrac{4.\dot{4} - 2.8\dot{3}}{1.\dot{3} + 2.6\dot{2}\dot{9}} \text{ of } 8.2\right\}$.

14. $\dfrac{.175 - .116 \text{ of } \dfrac{.1\frac{1}{2}}{3\frac{1}{3}}}{.083 \text{ of } \dfrac{1\frac{2}{7}}{2\frac{2}{7}} + .55}$. 15. $\dfrac{.\dot{0}7692\dot{3}}{.\dot{0}3\dot{7}} \times \dfrac{999}{.\dot{0}2\dot{7}} \times \dfrac{.001}{111} \times \dfrac{13}{.\dot{0}0\dot{9}}$.

16. $\dfrac{9.\dot{6}}{3.\dot{3}} \times \dfrac{14.02\dot{3}}{9} \times 1\dfrac{1}{29} \times .\dot{3} \times 1.\dot{7}4\dot{1} \div .\dot{0}0\dot{6} \times \dfrac{30}{4207}$.

XXVII. DECIMAL MEASURES.

158. *Example* 1. Reduce R3·4 to pies.

Process :

$$\begin{array}{r} \text{R}3\cdot4 \\ 16 \\ \hline 54\cdot4a. \\ 12 \\ \hline 652\cdot8p. \end{array} \quad \textit{Ans.}$$

Example 2. Find the value of 4·135 of £1.

Process : £4·135 — The £4 is not reduced to shillings.

$$\begin{array}{r} 20 \\ \hline s.\ 2\cdot700 \end{array}$$ — The 2*s.* is not reduced to pence.

$$\begin{array}{r} \hline d.\ 8\cdot4 \end{array}$$

∴ 4·135 of £1 = £4. 2*s* 8·4*d.*

Example 3. How many rupees, annas and pies are there ·522 of R5 ?

Process :

$$\begin{array}{r} \cdot522 \\ 5 \\ \hline \text{R}2\cdot610 \\ 16 \\ \hline a.\ 9\cdot76 \\ 12 \\ \hline p.\ 9\cdot12 \end{array}$$

∴ ·522 of R5 = R2. 9*a.* 9·12 *p.*

Example 4. Find the value of ·25 of £9 7*s.* 6*d.*

Process : £9. 7*s.* 6*d.* = 2250*d.*

$$\begin{array}{r} \cdot25 \\ 2250 \\ \hline 125 \\ 50 \\ 50 \\ \hline 12)\ 562\cdot50d. \\ \hline 20)\ 46s.\ 10\cdot5d. \\ \hline £2.\ 6s.\ 10\cdot5d. \end{array}$$

∴ ·25 of £9. 7*s.* 6*d.* = £2. 6*s.* 10½*d.*

Example 5. Find the value of ·2$\dot{3}$ of R10. 5*a.*,

Process : ·2$\dot{3}$ of R10. 5*a.* = $\frac{7}{30}$ of R10. 5*a.* = etc.

EXAMPLES. 100.

Reduce

1. R7·15 to pies.
2. ·0234375 of R1 to pies.
3. £·134375 to pence.
4. ·00375 of £1 to farthings.
5. ·03125 of R5 to pies.
6. ·045 of £7 to farthings.
7. R8·2$\frac{3}{4}$ to pies.
8. ·0$\dot{7}$ of £5 to pence.
9. ·895 cwt. to ounces.
10. 3·985 poles to inches.

Express as compound quantities :

11. R7·325.
12. £3·35.
13. R2·02.
14. 2·575 of 15*a*.
15. 3·45 of 16*s*.
16. ·06 of R13·5.
17. 3·725 of R9·2.
18. ·032 of 12 yd.
19. ·234 ton.

Find the value of

20. ·625 of R1. 4*a*. 4*p*.
21. ·725 of R9. 6*a*.
22. R9. 2*a*. × 1·35.
23. ·6 of R7. 9*a*. 10*p*.
24. 3·9 of R11. 9*a*.
25. ·079 of R35·5.
26. ·256 of £3. 4*s*. 9*d*.
27. ·1875 of 9*s*. 4$\frac{1}{2}$*d*.
28. ·0625 of 3·6*s*.
29. R3. 3*a*. 8*p*. × ·785.
30. £6 × ·78125.
31. 3*s*. 6$\frac{1}{2}$*d*. × ·45.
32. 3 md. 7 seers 9 ch. × 3·24.
33. 2 tons 3 cwt. 2 qr. 8 lb. × ·65.
34. 3 po. 2 yd. 1$\frac{1}{2}$ in. × ·725.
35. 1 da. 3 hr. 3 min. 7 sec. × ·825.
36. 3·$\dot{4}$ of R2. 4*a*.
37. ·$\dot{6}\dot{3}$ of 3*s*. 6$\frac{1}{2}$*d*.
38. R7. 9*a*. ÷ ·0$\dot{6}$.
39. R3. 4*a*. 9*p*. ÷ ·422.
40. £7. 8*s*. 2*d*. ÷ ·044.
41. 11·1375 of R6. 8*a*. − ·56 of R7. 8*a*.
42. ·8$\dot{3}$ of R2. 8*a*. + ·6 of R4. 11*a*. + 2·05 of R5.
43. ·375 of R9 + ·8$\dot{3}$ of 10*a*. − ·$\dot{6}$ of 6*p*.
44. ·01$\dot{6}$ of R260. 2*a*. 6*p*. + ·$\dot{3}$5$\dot{1}$ of R13. 14*a*. + 1·0$\dot{0}$03$\dot{3}$ of R7. 14*a*. 3*p*.
45. ·03125 of R2 + ·$\dot{7}$2$\dot{9}$ of R3$\frac{1}{17}$ + ·$\dot{7}$2$\dot{9}$ of R3$\frac{5}{8}$.
46. £·634375 + ·025 of 25*s*. + ·325 of 30*s*.
47. 8·71875 of 8*d*. + 1·146875 of 6*s*. 8*d*. − ·0625 of 1 guinea.
48. 6·8$\dot{3}$ of £3·8677083$\dot{3}$ + 5·8 of £2·4114583$\dot{3}$ − 4·375 of £1·3.

Arrange in order of magnitude :

49. $\frac{11}{15}$ of R3. 9*a*., ·025 of R100. 10*a*., ·3$\dot{2}$ of R5. 8*a*.
50. ·003$\frac{1}{4}$ of £1, ·256 of 1*s*., 3$\frac{1}{3}$ of 1*d*.
51. What is the sum, ·75 of which is R3. 9*a*. 3*p*.?
52. $\frac{4}{7}$ of ·72 of a sum of money is 3*s*. 6*d*.; what is ·0$\dot{3}$ of the sum ?
53. Simplify $\dfrac{\cdot 625 \text{ of } £143.\ 12s. + \cdot 625 \text{ of } £71.\ 16s.}{\frac{5}{8} \text{ of } 5175}$.

54. Simplify $\cdot 42\dot{6}$ of $\dfrac{3\cdot\dot{3}}{\cdot 08}$ of $\dfrac{\cdot 3}{\cdot 73\dot{5}}$ of $\dfrac{\cdot 147 \times 4\cdot\dot{4}}{11\cdot 1}$ of £1 17*s.* 6*d.*

55. Multiply ·892 of R16. 5*a.* 4*p.* by 4·678.

56. Find the value of $\cdot\dot{8}5714\dot{2}$ of 2·0625 tons + $\cdot\dot{5}7142\dot{8}$ of 3·375 cwt. + $\cdot\dot{7}1428\dot{5}$ of 1·25 qr. + $\cdot\dot{2}8571\dot{4}$ of 10·5 lb.

57. Find the value of $\cdot\dot{0}\dot{9}$ of 1·5 md. + $\cdot 2\dot{7}$ of 2·25 md. + $\cdot\dot{6}\dot{3}$ of 7·75 md. + $\cdot\dot{4}\dot{5}$ of ·7 md.

58. Find the greatest sum of money which is contained in each of ·25 of 5*s.* 6*d.* and $\cdot 0\dot{5}$ of £1 a whole number of times.

159. The following examples illustrate the *converse* operation :

Example 1. Reduce 1000 pies to rupees.

$$1000p. = \text{R}\frac{1000}{12\times 16} = \text{R}\frac{125}{24} = \text{R}5\cdot 208\dot{3}. \quad Ans.$$

Example 2. Reduce £1. 3*s.* 6*d.* to the decimal of £1.

$$£1.\ 3s.\ 6d. = £1.\ 42d. = £1\frac{42}{12\times 20} = £1\frac{7}{40} = £1\cdot 175\ ;$$

$\therefore$ the decimal = 1·175.

Example 3. Express $\cdot\dot{3}$ of R1. 3*a.* 6*p.* as the decimal of 4*a.* 10*p.*

$$\text{The decimal} = \frac{\cdot\dot{3} \text{ of R}1.3.6}{4a.\ 10p.} = \frac{\frac{1}{3}\times 234}{58} = \frac{234}{3\times 58} = \frac{39}{29} = 1\cdot 3448\cdots$$

EXAMPLES. 101.

Reduce

1. 3333 pies to rupees. **2.** 8446*q.* to pounds.

3. 10000 lb. to tons. **4.** 90000 in. to miles.

5. 66666 sec. to days. **6.** 39 guineas to pounds.

Express each of the following as a decimal of its *highest* denomination.

7. 7*a.* 9*p.* **8.** R3. 10*a.* 3*p.* **9.** R5. 5*a.* 5*p.*

10. 8*s.* 6*d.* **11.** £1. 3*s.* 8*d.* **12.** £7. 6*s.* 4½*d.*

13. 1 md. 15 seers. **14.** 3 cwt. 3⅜ qr. **15.** 5 po. 4 yd.

16. 7 da. 5⅘ hr. **17.** 1 ac. 20 yd. 3 ft. **18.** 7°. 2′. 20″.

In the following examples, reduce the first of the two given quantities to the decimal of the second.

19. R3. 4*a.* 9*p.* ; R5. **20.** £7. 10*s.* 4½*d.* ; £10.

21. 9a. 4p.; 11a. 3p.

22. R7. 9a. 10p.; R12. 4a. 4p.

23. 7s. 6d.; 15s. 7d.

24. £3. 10s. 9$\frac{1}{2}$d.; £6. 2s. 4$\frac{1}{2}$d.

25. $\frac{3}{4}$ of £1. 8s. 6d.; £1.

26. $\frac{7}{8}$ of R3. 9a. 4p.; R3.

27. ·375 of R10. 10a. 10p.; R3. 13a. 3p.

28. 9a. 8p.; ·3$\dot{8}$ of R3. 4a.

29. ·35 of £7. 3s. 4$\frac{1}{2}$d.; ·0$\dot{5}$ of £3.

30. ·00$\dot{3}$ of £1; ·$\dot{7}$ of 9s. 4$\frac{1}{2}$d.

31. ·25 of 3a. 4p.; ·0$\dot{6}$ of R3.

32. 2$\frac{2}{23}$ of £2. 6s. 5$\frac{3}{4}$d.; £18. 17s. 10$\frac{3}{4}$d.

33. Express $\frac{5}{8}$ of 12s. 6d. + ·625 of 7s. 6d. − ·5$\dot{0}\dot{5}$ of 16s. 6d. as the decimal of £1.

34. Reduce $\frac{3}{8}$ of R·05 + $\frac{1}{10}$ of 4a. + $\frac{3}{4}$ of R1 to the decimal of R$\frac{3}{64}$.

35. Express ·$\dot{4}$2857$\dot{1}$ of £1·05 + ·3$\dot{8}$ of 1·5s. as the decimal of £43. 2s. 6d.

36. Reduce ·$\dot{2}$4$\dot{6}$ of 9s. 3d. + ·25$\dot{9}$ of £1. 5s. + ·0$\dot{2}$ of £3. 7s. 6d. to the decimal of ·0$\dot{3}$ of £90.

37. Reduce ·062135 of £100 + 7·4375 of 10s. + 1·35$\dot{6}$ of 7s. 6d. + 2·784 of 2$\frac{1}{2}$d. to the decimal of £29. 10s. 7$\frac{1}{2}$d.

38. What decimal of R3. 9a. must be added to ·0$\dot{7}\dot{5}$ of 5a. 6p. to make the sum equal to 1 anna?

39. What decimal of £6. 10s. must be taken from $\frac{3}{4}$ of £9 that the remainder may be £6. 10s.?

40. Express £874. 13s. 4d. × 3·75 as the decimal of £10000.

MISCELLANEOUS EXAMPLES. 102.

1. Give the local value of each of the significant digits in ·02073.

2. Express the difference between 2·$\dot{7}\dot{6}$ and 2·7$\dot{6}$, (i) by a circulating decimal, and (ii) by a vulgar fraction.

3. Express $\frac{1}{8}$(3$\frac{1}{2}$ + 2$\frac{3}{4}$ − 4) as a decimal, and ·6 + $\frac{4}{11}$ of ·025 + 3·0$\dot{6}$ as a vulgar fraction.

4. Reduce $\frac{3}{25}$ of 2·35 ÷ 1000 to a decimal.

5. Find the least number which must be subtracted from the sum of 2·36 and 3·002 that the remainder may be an integer.

6. Find the price of 321 yards of cloth at 11·25 annas per yard.

7. Find the total weight of 324 bags, each 13·75 lb.

8. By what decimal do we divide 3$\frac{1}{4}$, if the quotient is 7·5?

9. R720 is ·08 of what amount?

10. If the divisor be 2·36 and the quotient ·125 of the divisor, what must the dividend be?

11. Divide 64·09 by 49·3, and arrange the divisor, dividend and quotient in order of magnitude

12. If the diameter of a pice be 1·025 inches, how many must be placed in contact along a straight line to extend from Calcutta to Hugly, a distance of 24·6 miles ?

13. How often will a wheel, 2·75 yards in circumference, turn in a distance of 12·5 miles ?

14. A vessel holds 3·256 gallons ; how many times can it be filled from a cask of 96 gallons ? Will there be any remainder ?

15. How many times can you subtract 3·01 from 65·23, and what is the remainder ?

16. Express as a decimal the continued product of $\frac{3}{8}$, $\frac{2\frac{1}{2}+1\cdot5}{8\cdot75}$ and $\frac{2\frac{1}{12}}{\cdot\dot{9}}$.

17. Express 21·43 crowns + 18·52 shillings in pence

18. Subtract 4·42 cwt. from 7·28 tons.

19. Express 2·75 oz. + ·075 cwt. in pounds.

20. Find the rent of 32·25 acres at £1·025 per acre.

21. If the product of ·064 and a certain number be divided by ·00008, the quotient is 3404 ; find the number.

22. A book containing 219 leaves is 1·34 inches thick ; allowing ·06 of an inch for the cover, find to 5 decimal places the thickness of the paper.

23. A roller 4·03 ft. in circumference makes 34·04 revolutions in passing from one end of a lawn to another ; what is the length of the lawn ?

24. From a rod 2 yards long, portions each ·063 of an inch in length are cut off ; how many such portions can be cut off, and what will be the length of the remaining piece ?

25. Find a decimal which shall differ from $\frac{8}{21}$ by less than $\frac{1}{10000}$.

26. Multiply 9·036 by itself in two lines.

27. Multiply 37·056 by 12·10411 in three lines.

28. Find the least number of articles, costing Rs2·375 each, that can be purchased for an integral number of rupees.

29. Find the smallest number of articles, costing £2. 6*s*. 2·37*d*. each, that you can buy for an exact number of pounds.

30. *A* did ·025 of a piece of work, and *B* ·825 ; how much was left to be done ?

31. A boy, after giving away ·8 of his pocket-money to one companion, and ·06 of the remainder to another, has 7*a*. 10*p*. left ; how much had he at first ?

32. A man received $\cdot 3\dot{8}$ of $\cdot 0\dot{3}$ of a property, and sold $\cdot\dot{3}$ of his own share for ₨350; what would be the value of the whole property at the same rate?

33. A gallon contains 277·274 cubic inches; how many cubic yards are there in 200 bushels?

34. A cubic foot of water weighs 62·35 lb. avoir.; what would be the error in calculating the weight of 30 cubic feet on the approximate supposition that a cubic foot of water weighs 1000 oz.?

35. A is ·75 times as old as B, and C $\cdot 7\dot{5}$ times as old as B; A is 15 years old: how old is C?

36. Four bells toll at intervals of 1·3, 1·4, 1·5 and 1·6 seconds, beginning together; after what interval will they toll together again?

37. Find the largest sum of money which is contained in £3·75 and £2·125 a whole number of times.

38. Divide ₨50 into two parts such that one part may be $\cdot\dot{6}$ of the other.

39. Divide £52 between A, B, C in such a manner that B may receive $\cdot\dot{3}$ of A, and C $\cdot\dot{3}$ of B.

40. Express $\dfrac{8\frac{11}{64}}{\frac{7}{8}\text{ of }2\cdot 25}$ of $\dfrac{\cdot 1625}{1\frac{1}{8}\text{ of }5\frac{4}{7}} \div \left(\dfrac{2}{21}+\dfrac{7}{81}\right)$ as a fraction of $\left\{37+\dfrac{3\cdot 7\dot{0}3\dot{7}}{100}\right\}$ of ·54.

XXVIII. APPROXIMATION.

160. It is often inconvenient, and not always possible, to find an *exact* decimal equivalent to a proposed number. In such cases we may proceed to a few places of decimals and indicate by dots (...) that the work has not terminated. Thus $\frac{22}{23}$ = ·95652... If however we wish to *approximate* to the result by terminating our work at any specified place, we should increase the last digit retained by 1 if the first digit rejected be 5 or greater than 5. Thus $\frac{22}{23}$ = ·957 *correct to three places of decimals* or *to the nearest thousandth*; also $\frac{22}{23}$ = ·9565 *to four places.*

Note. It will be easily seen that the difference of ·957 and ·95652... is less than the difference of ·95652... and ·956; hence ·957 represents ·95652... more accurately than ·956. It may be noticed that the approximate result is less than the actual result when the first figure rejected is less than 5, but greater when not less.

161. Contracted Addition and Subtraction.

Example 1. Find the sum of $\cdot 23\dot{6}\dot{7}$, $\cdot 3\dot{1}7\dot{8}$ and $1\cdot 62$ correct to four places of decimals.

We write down each decimal to 7 places, and obtain correctly 5 decimal places in the sum ; the required result is then obtained by rejecting the fifth place.

$$\begin{array}{l} \cdot 2367|676 \\ \cdot 3178|178 \\ 1\cdot 62 \quad | \\ \hline 2\cdot 1745|8\ldots = 2\cdot 1746. \quad \textit{Ans.} \end{array}$$

Example 2. Find the difference between $\cdot 6\dot{3}2\dot{1}$ and $\cdot 00\dot{8}$ correct to five places of decimals.

Process:

$$\begin{array}{l} \cdot 63213|213 \\ \cdot 00888|888 \\ \hline \cdot 62324|3\ldots = \cdot 62324. \quad \textit{Ans.} \end{array}$$

Example 3. Find the value of $1 + \frac{1}{1.2} + \frac{1}{1.2.3} + \ldots\ldots$ correct to 3 places of decimals.

$$1 = 1\cdot 000\,000$$

$$\therefore \quad \frac{1}{1.2} = \frac{1}{2} = \cdot 500|000$$

$$\therefore \quad \frac{1}{1.2.3} = \frac{\cdot 5}{3} = \cdot 166|666$$

$$\therefore \quad \frac{1}{1.2.3.4} = \frac{\cdot 166666}{4} = \cdot 041|666$$

$$\therefore \quad \frac{1}{1.2.3.4.5} = \frac{\cdot 041666}{5} = \cdot 008|333$$

$$\therefore \quad \frac{1}{1.2.3.4.5.6} = \frac{\cdot 008333}{6} = \cdot 001|388$$

$$\therefore \quad \frac{1}{1.2.3.4.5.6.7} = \frac{\cdot 001388}{7} = \cdot 000|198$$

$$\therefore \quad \frac{1}{1.2.3.4.5.6.7.8} = \frac{\cdot 000198}{8} = \cdot 000|024$$

$$\therefore \quad \frac{1}{1.2.3.4.5.6.7.8.9} = \frac{\cdot 000024}{9} = \cdot 000|002$$

and $\therefore$ the expression $= 1\cdot 718|2\ldots$

$= 1\cdot 718$, to 3 places.

Here we stop at $\frac{1}{1.2.3.4.5.6.7.8.9}$, as in the decimals equivalent to the succeeding fractions, the first six figures will be zeros.

EXAMPLES. 103.

1. Find the quotient of 40 divided by 19 correct to four places of decimals.

2. Obtain the decimal equivalent to $\frac{1}{17}$ correct to five places of decimals.

3. Find the value of $\cdot 0312 + \cdot 02\dot{3}\dot{1} + \cdot\dot{9}7\dot{6}$ correct to four places of decimals.

4. Find the sum of 72, $3\cdot 012\dot{3}$ and $\cdot 00123\dot{4}$ correct to three places of decimals.

5. Find the difference between $\cdot\dot{4}32\dot{5}$ and $\cdot 0\dot{3}76\dot{4}$ correct to four places of decimals.

Find the value, correct to 2 places of decimals, of

6. $1 + \frac{1}{10} + \frac{1}{100} + \frac{1}{1000} + \dots$ 7. $1 + \frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \frac{1}{16} + \dots$

8. $1 + \frac{1}{3} + \frac{1}{9} + \frac{1}{27} + \dots$ 9. $1 + \frac{1}{4} + \frac{1}{16} + \frac{1}{64} + \dots$

Find the value, correct to 3 places of decimals, of

10. $1 + \frac{1}{5} + \frac{1}{5^2} + \frac{1}{5^3} + \dots$ 11. $1 + \frac{1}{7} + \frac{1}{7^2} + \frac{1}{7^3} + \dots$

Find the value, correct to 5 places of decimals, of

12. $\cdot 25 + (\cdot 25)^3 + (\cdot 25)^5 + \dots$ 13. $1 + \frac{1}{1.3} + \frac{1}{1.3.5} + \frac{1}{1.3.5.7} + \dots$

14. $\frac{1}{1}\cdot\frac{1}{2^2} + \frac{1}{2}\cdot\frac{1}{2^4} + \frac{1}{3}\cdot\frac{1}{2^6} + \frac{1}{4}\cdot\frac{1}{2^8} + \dots$

[First express as decimals $\frac{1}{2^2}, \frac{1}{2^4}, \frac{1}{2^6}, \dots$, then divide the results respectively by 1, 2, 3,..., and add.]

15. $\frac{1}{1}\cdot\frac{1}{5} + \frac{1}{3}\cdot\frac{1}{5^3} + \frac{1}{5}\cdot\frac{1}{5^5} + \frac{1}{7}\cdot\frac{1}{5^7} + \frac{1}{9}\cdot\frac{1}{5^9} + \dots$

CONTRACTED MULTIPLICATION.

162. The following rule will shorten the process of multiplication when the product is required only to a certain number of decimal places.

To multiply two decimals together, retaining, say, 5 decimal places :—"Reverse the multiplier, strike out the decimal points, and place the multiplier under the multiplicand, so that what was its units' figure shall fall under the 5th decimal place of the multiplicand, placing ciphers, if necessary, so that every place of the multiplier shall have a figure above it. Proceed to multiply as usual, beginning each figure of the multiplier with the one which is in the place

to its right in the multiplicand : do not set down from this product but carry its *nearest ten** to the next, and proceed. Place the first figures of all the lines under one another ; add as usual ; and mark off 5 places from the right for decimals."—[De Morgan]

Example. Multiply 7·2078 by 2·3072, retaining 5 places ; ·00705328 by 12·30523, retaining 6 places ; and 29·82 by ·00727, retaining 4 places of decimals.

(i)	(ii)	(iii)
720780	705328	29820
27032	3250321	72700
1441560	70533	2087
216234	14106	60
5045	2116	20
144	35	·2167
16·62983	1	
	·086791	

Note. The last figure in the product thus obtained may not be always correct, and to ensure its accuracy we must carry the process one place farther than is required to be retained.

CONTRACTED DIVISION.

162a. The following rule will shorten the process in division when the quotient is required to be correct only to a certain number of decimal places.

Make the divisor a whole number ; and determine by inspection (or by taking one step in the ordinary way), how many figures there will be in the integral part of the quotient. In the divisor retain (from the left) as many figures as there are to be in the whole quotient—integral part as well as decimal ; and strike off the rest. Proceed one step with this new divisor, but to the product of its first figure by the quotient-figure, carry the *nearest ten* from the preceding figure. Instead of bringing down a figure to the remainder, strike off another figure from the divisor, and proceed as before, until no figure is left in the divisor.

If the number of figures in the divisor be less than the number of quotient-figures to be obtained, proceed in the ordinary way until the number of quotient-figures still to be obtained, is one less than the number of figures in the divisor. As soon as this happens, instead of bringing down a figure to the remainder, strike off a figure from the end of the divisor, and then proceed as in the preceding case.

* That is, carry 1 if the product is a number from 5 to 14 ; carry 2 if it is from 15 to 24 ; carry 3 if it is from 25 to 34 ; etc ; if the product is 4 or less, we ignore it.

Example. Divide 29·431542 by 3·25348 to 3 decimal places; and 673·1489 by ·41432 to 2 places.

(i) 3.2.5.3.4.8) 2943154·2 (9·046
29281
150
130
20
19
1

(ii) 4.1.4.3.2) 67314890· (1624·70
41432
258828
248592
10236
8286
1950
1657
293
290
3

EXAMPLES. 103a.

Multiply

1. 21·1324 by ·345721 to 3 decimal places.
2. ·32504 by 13·0254 to 3 ... ...
3. ·453 by ·01694 to 4 ... ...
4. 375·76843 by 3·14159 to 4 ... ...
5. 71·032751 by 2·6719238 to 5 ... ...
6. 65·00763 by ·9876 to 5 ... ...
7. ·03281674 by 234·781 to 6 ... ...
8. ·0008127 by 483·2716 to 6 ... ...
9. 4·68$\dot{3}$ by 14·$\dot{2}$9$\dot{3}$ to 3 ... ...
10. 1·$\dot{8}$2357$\dot{7}$ by ·0$\dot{7}$8$\dot{5}$ to 6 ... ...

Divide

11. 76·2307 by 47·12345 to 3 decimal places.
12. 3·3706 by 9·7846 to 3 ... ...
13. 32·791 by 26·67 to 3 ... ...
14. 378·325 by 30·732 to 3 ... ...
15. 36·7802 by 312·32 to 4 ... ...
16. 728·389 by 3·76 to 4 ... ...
17. 3892·762 by 7·343 to 5 ... ...
18. 23·78934 by ·00289 to 5 ... ...
19. 13·2346891 by ·01234031 to 6 ... ...
20. 132·405678 by ·000122134 to 7 ... ...
21. 3·7$\dot{4}\dot{5}$ by 13·$\dot{4}$3$\dot{4}$ to 3 ... ...
22. 1·$\dot{8}$2357$\dot{7}$ by ·0$\dot{7}$8$\dot{5}$ to 6 ... ...

XXIX. PRACTICE.

163. An **aliquot part** of a quantity is a quantity which can be expressed as a fraction of that quantity, having *unity* for its numerator.

Thus 4*a*., being $\frac{1}{4}$ of R1, is an aliquot part of R1 ; 2*s*. 6*d*, which is $\frac{1}{8}$ of £1, is an aliquot part of £1.

164. Simple Practice is a convenient method of finding, by means of aliquot parts, the cost of a *simple quantity*, when the cost is given of the unit-quantity, in terms of which the simple quantity is expressed.

Example. Find the value of 32 cwt. of wheat at R3. 8*a*. per cwt.

Compound Practice is a convenient method of finding, by means of aliquot parts, the cost of a *compound quantity*, when the cost is given of one of the units, in terms of which the compound quantity is expressed.

Example. Find the value of 7 cwt. 3 qr. of wheat at R3. 8*a*. per cwt.

SIMPLE PRACTICE.

165. The following examples will explain the method of Simple Practice.

Example 1. Find the price of 23 md. of rice at R3. 13*a*. 9*p*. per md.

	R.	*a*.	*p*.	
	23	0	0	= price at R1 per md.
			3	
	69	0	0	= price at R3 per md.
8*a*. = $\frac{1}{2}$ of R1	11	8	0	= „ „ 8*a*. „ „
4*a*. = $\frac{1}{2}$ of 8*a*.	5	12	0	= „ „ 4*a*. „ „
1*a*. = $\frac{1}{4}$ of 4*a*.	1	7	0	= „ „ 1*a*. „ „
6*p*. = $\frac{1}{2}$ of 1*a*.		11	6	= „ „ 6*p*. „ „
3*p*. = $\frac{1}{2}$ of 6*p*.		5	9	= „ „ 3*p*. „ „
	R88	12	3	= price at R3. 13*a*. 9*p*. per md.

Note 1. Since R3 . 13 . 9 is the difference between R4 and 2*a*. 3*p*., a shorter method would be to find the price at 2*a*. 3*p*. per md. and subtract it from the price at R4 per md.

Thus :

	R.	a.	p.	
	23	0	0	
			4	
	92	0	0	= price at R4 per md.
	3	3	9	= " " 2*a.* 3*p.* " "
	R88	12	3	= price at R3. 13*a.* 9*p.* per md.

	R.	a.	p.	
	23	0	0	
2*a.* = $\frac{1}{8}$ of R1	2	14	0	
3*p.* = $\frac{1}{8}$ of 2*a.*		5	9	
	R3	3	9	= price at 2*a.* 3*p.* per md.

Example 2. Find the cost of 9 articles at £10. 12*s.* 6*d.* each.

		£.	s.	d.	
		9	0	0	= cost at £1 each.
				10	
		90	0	0	= cost at £10 each.
10*s.*	$\frac{1}{2}$ of £1	4	10	0	= " " 10*s.* "
2*s.*	$\frac{1}{5}$ of 10*s.*		18	0	= " " 2*s.* "
6*d.*	$\frac{1}{4}$ of 2*s.*		4	6	= " " 6*d.* "
		£95	12	6	= cost at £10. 12*s.* 6*d.* each.

Note 2. Shorter thus : 10*s.* = $\frac{1}{2}$ of £1 ; 2*s.* 6*d.* = $\frac{1}{4}$ of 10*s.*

Example 3. Find the value of 13½ cwt. at R7. 10*a.* 3*p.* per cwt.

		R.	a.	p.	
		13	8	0	= value at R1 per cwt.
				7	
		94	8	0	= value at R7 per cwt.
8*a.*	$\frac{1}{2}$ of R1	6	12	0	= " " 8*a.* " "
2*a.*	$\frac{1}{4}$ of 8*a.*	1	11	0	= " " 2*a.* " "
3*p.*	$\frac{1}{8}$ of 2*a.*		3	4½	= " " 3*p.* " "
		R103	2	4½	= value at R7. 10*a.* 3*p.* per cwt.

Or thus :

		R.		
		13·5	R.	·1484375
		7		16
		94·5	*a.*	2·3750000
8*a.*	$\frac{1}{2}$ of R1	6·75		12
2*a.*	$\frac{1}{4}$ of 8*a.*	1·6875	*p.*	4·500
3*p.*	$\frac{1}{8}$ of 2*a.*	·2109375		
		R103·1484375	*Ans.*	R103. 2*a.* 4½*p.*

Example 4. Find the value of $42\frac{2}{3}$ things at 16s $2\frac{1}{4}d.$ each.

		£.	s.	d	
		42	13	4	= value at £1 each.
10s.	$\frac{1}{2}$ of £1.	21	6	8	= value at 10s. each.
5s.	$\frac{1}{2}$ of 10s.	10	13	4	= " " 5s. "
1s.	$\frac{1}{5}$ of 5s.	2	2	8	= " " 1s. "
2d.	$\frac{1}{6}$ of 1s.		7	$1\frac{1}{3}$	= " " 2d. "
$\frac{1}{2}d.$	$\frac{1}{4}$ of 2d.		1	$9\frac{1}{3}$	= " " $\frac{1}{2}d.$ "
$\frac{1}{4}d.$	$\frac{1}{2}$ of $\frac{1}{2}d.$			$10\frac{2}{3}$	= " " $\frac{1}{4}d$ "
		£34	12	$5\frac{1}{3}$	= value at 16s. $2\frac{1}{4}d.$ each.

EXAMPLES. 104.

Find, by Practice, the cost of the following articles :

1. 400 at R3. 4a. each.
2. 375 at £2. 5s. each.
3. 789 at 1a.
4. 728 at 3d.
5. 439 at 3p.
6. 399 at £4. 4s.
7. 874 at 6a.
8. 723 at 15s.
9. 939 at R2. 11a.
10. 275 at 4d.
11. 475 at 13a. 6p.
12. 342 at 2s. 6d.
13. 500 at 7a. 3p.
14. 942 at 7s. 3d.
15. 700 at 10a. $4\frac{1}{2}p.$
16. 374 at $5\frac{1}{2}d.$
17. 321 at R2. 5a. 3p.
18. 230 at £7. 10s. 6d.
19. 366 at R7. 11a. 9p.
20. 767 at £10. 8s. 8d.
21. 839 at R5. 13a. 4p.
22. 339 at 14s. $10\frac{1}{4}d.$
23. 454 at R15. 7a. $10\frac{1}{2}p.$
24. 900 at £50. 11s. $9\frac{3}{4}d.$
25. 900 at R42. 10a. $7\frac{1}{2}p.$
26. 5013 at £55. 19s. $1\frac{1}{2}d.$
27. 768 at R19. 9a. 3 *pice.*
28. 1010 at £11. 11s. $11\frac{3}{4}d.$
29. 8760 at R31. 14a. 2 *pice.*
30. 4596 at 12s. $0\frac{3}{4}d.$
31. 555 at R89. 3a. $5\frac{1}{2}p.$
32. 3111 at £12. 12s. $3\frac{3}{4}d.$
33. 8001 at R80. 8a. $8\frac{1}{2}p.$
34. 10000 at £7. 17s. $11\frac{1}{2}d.$
35. $346\frac{1}{2}$ at R8. 10a. 8p.
36. $27\frac{3}{4}$ at £8. 16s. $7\frac{3}{4}d.$
37. $703\frac{3}{8}$ at R29. 13a. $4\frac{1}{2}p.$
38. $301\frac{1}{4}$ at £2. 15s. $7\frac{3}{4}d.$
39. $871\frac{3}{4}$ at R41. 7a. $5\frac{3}{4}p.$
40. $442\frac{2}{3}$ at £76. 2s. $4\frac{3}{4}d.$
41. $600\frac{1}{16}$ at R12. 12a. 2p.
42. $249\frac{7}{16}$ at £20. 2s. $8\frac{1}{2}d.$
43. 39·5 at R1. 13a. 4p.
44. 84·75 at £2. 15s. 9d.
45. 101·375 at R10. 9a. 6p.
46. 10·875 at £2. 17s. $10\frac{1}{2}d.$

COMPOUND PRACTICE.

166. The method of Compound Practice is illustrated by the following Examples.

Example 1. Find the price of 15 md. $12\frac{1}{2}$ seers at ₨2. 5*a*. 3*p*. per md.

	R.	a.	p.	
	2	5	3	= price of 1 md.
			3	
	6	15	9	
			5	
	34	14	9	= price of 15 md.
10 seers | $\frac{1}{4}$ of 1 md.		9	$3\frac{3}{4}$	= " " 10 seers.
$2\frac{1}{2}$ seers | $\frac{1}{4}$ of 10 seers		2	$3\frac{15}{16}$	= " " $2\frac{1}{2}$ seers.
	₨35	10	$4\frac{11}{16}$	= price of 15 md. $12\frac{1}{2}$ seers.

Example 2. Find the cost of 2 tons 3 cwt. 3 qr. 5 lb. at £15. 17*s*. per cwt.

	£.	s.	d.	
2 tons 3 cwt. = 43 cwt.	15	17	0	= cost of 1 cwt.
			10	
	158	10	0	
			4	
	634	0	0	= cost of 40 cwt.
	47	11	0	= " " 3 cwt.
	681	11	0	= cost of 43 cwt.
2 qr. | $\frac{1}{2}$ of 1 cwt.	7	18	6	= " " 2 qr.
1 qr. | $\frac{1}{2}$ of 2 qr.	3	19	3	= " " 1 qr.
4 lb. | $\frac{1}{7}$ of 1 qr.		11	$3\frac{6}{7}$	= " " 4 lb.
1 lb | $\frac{1}{4}$ of 4 lb.		2	$9\frac{27}{28}$	= " " 1 lb.
	£694	2	$10\frac{23}{28}$	= cost of 2 tons 3 cwt. 3 qr. [5 lb.

Example 3. Find the value of 25 sacks of flour, each weighing 3 md. 10 seers, at ₨5. 8*a*. per maund.

	R.	a.	p.	
	5	8	0	= value of 1 md.
			3	
	16	8	0	= " " 3 md.
10 seers = $\frac{1}{4}$ of 1 md.	1	6	0	= " " 10 seers.
	17	14	0	= value of 1 sack.
			5	
	89	6	0	
			5	
	₨446	14	0	= value of 25 sacks.

EXAMPLES. 105.

Find, by Practice, the value of

1. 7 md. 15 seers at ₨3. 7*a*. 8*p*. per md.
2. 9 md. 17½ seers at ₨4. 10*a*. 8*p*. per md.
3. 27 cwt. 2 qr. 7 lb. at £3. 7*s*. 6*d*. per cwt.
4. 11 tons 14 cwt. at £5. 17*s*. 6*d*. per ton.
5. 17 tons 15 cwt. 2 qr. 21 lb. at £3. 15*s*. 9*d*. per cwt.
6. 6 tons 3 cwt. 2 qr. 24 lb. at 17*s* 7*d*. per cwt.
7. 2 tons 13 cwt. 3 qr. 7 lb. at £1. 1*s*. 4*d*. per cwt.
8. 3 md. 27 seers 8 ch. at ₨10. 5*a*. 8*p*. per md.
9. 7 md. 18 seers 9 ch. at ₨13. 7*a*. 5*p*. per md.
10. 8 md. 3 seers 12 ch. at 3*a*. 4*p*. per seer.
11. 1 md. 17 seers 10 ch. at 7*a*. 6*p*. per seer.
12. 4 cwt. 3 qr. 14 lb. at £1. 13*s*. 4*d*. per ton.
13. 7 cwt. 2 qr. 21 lb. at £6 per ton.
14. 3 tons 17 cwt. 3 qr. 13 lb. 12 oz. at £1. 18*s*. 9*d*. per cwt.
15. 3 md. 37 seers 12 ch. at 7*s*. 6*d*. per seer.
16. 2 tons 7 cwt. 1 qr. 13 lb. 14 oz. at ₨9. 11*a*. per qr.
17. 7 sacks of flour, each 3 md. 15 seers, at ₨7. 10*a*. per md.
18. 24 bales of cotton, each 5 cwt. 2 qr., at 16*s*. 7¾*d*. per cwt.
19. 35 chests of tea, each 1 md. 17 seers 9 ch., at ₨80. 12*a*. per md.
20. 321 boxes of coffee, each 1 cwt. 2 qr. 21 lb., at £7. 18*s*. per cwt.
21. Find the total produce of a field of 3 ac. 3 ro. 25 po. at 3 qr. 6 bus. 2 pk. per acre.
22. Find the produce of 2 ac. 2 ro. 88 sq. yd. at 7 cwt. 3 qr. 14 lb. per acre.
23. Find the price of 29 yd. 2 ft. 9 in. of silk at 7*s*. 10½*d*. per yd.
24. Find the weight of 231 bales of cloth, each weighing 2 cwt. 2 qr. 14 lb.
25. Find the weight of 329 boxes, each weighing 7 md. 27½ seers.
26. Find the tax on £329. 15*s*. at 1*s*. 7½*d*. in the £.
27. Find the tax on ₨3090. 8*a*. at 1*a*. 4½*p*. in the ₨.
28. Find the cost of 5 qr. 3 bus. 2 pk. of oats at £2. 14*s*. 4*d*. per qr.

29. Find the price of 12 gall. 3 qt. $1\frac{1}{2}$ pt. of milk at R3. 8*a*. per gallon.

30. Find the value of 225 cwt. at £21. 5*s*. 7*d*. per ton.

31. Find the value of 257 things, 10 of which cost R3. 9*a*. 4*p*.

32. Find, to the nearest pie, the rent of 275·365 bighas at R3. 7*a*. 9*p*. per bigha.

33. Find the value of 1 ton 11 cwt. 1 qr. 11 lb. at £6·285 per ton.

34. Find the dividend on R5146. 12*a*. at 14*a*. 6*p*. in the R.

35. If a man's debts amount to R37925. 14*a*. and he can pay only 3*a*. $4\frac{1}{2}$*p*. for each rupee, how much do his creditors get?

XXX. SQUARE ROOT.

167. A number is called the **square root** of its square. Thus 2 is the square root of 4; 3 is the square root of 9.

The square root of a number is indicated by the symbol $\sqrt{}$ placed before it. Thus $\sqrt{4}$ indicates the *square root of* 4, that is, 2.

168. A number whose square root can be expressed exactly either by a whole number or by a fraction is called a **perfect square.**

Note. It may be noticed that, no number, integral or decimal, which ends with 2, or 3, or 7, or 8, is a perfect square.

169. When the square root of a whole number which is a perfect square does not exceed 20, we obtain it from the multiplication table. Thus from the table we know that the square root of 81 is 9; of 169 is 13. We have, however, a rule by which we can find the square root of any number consisting of more than two figures.

170. We observe that the square root of 100 is 10, of 10,000 is 100, of 1,000,000 is 1,000; and so on. Hence it follows that the square roots of numbers less than 100 consist of only *one* figure in their integral parts; of numbers between 100 and 10,000, of two figures in their integral parts; of numbers between 10,000 and 1,000,000, of three figures in their integral parts; and so on. If then a point be placed over every second figure in any number beginning with the *units'* the number of points will be the same as the number of figures in the integral part of the square root. Thus the square root of $\dot{3}1\dot{3}\dot{6}$ consists of two figures in its integral part; the square root of $\dot{1}5\dot{6}2\dot{5}$ consists of three figures in its integral parts.

171. Now suppose we have to extract the square root of 2136.

We first divide the number into periods of two figures each, by placing dots over every second figure beginning with the units.*

```
     3̇13̇6 ( 56
     25
106 ) 636
      636
```

We then find the greatest number (**5**) whose square is contained in the first period; this is the first figure of the root; then subtract its square (25) from the first period and to the remainder (6) bring down the second period, thus getting 636 for the new dividend. Next, we divide this number omitting the last figure, by twice the part of the root already found (*i.e.*, we divide 63 by 10), and annex the quotient (**6**) to the root and also to the *trial divisor* (10); then multiply the divisor as it now stands (106) by the figure of the root last found. Now, subtracting this product from 636, we have no remainder: and we conclude that 56 is the square root of 3136.

If there be more periods to be brought down, the above operation must be repeated, as in the annexed example.

```
      1̇56̇25̇ ( 125
      1
 22 ) 56
      44
245 ) 1225
      1225
```

Here, after two figures in the root have been obtained, the remainder is 12; to this we bring down the third period, thus getting 1225 as the last dividend. We divide this number, last figure omitted, by twice the part of the root already found (*i.e*, we divide 122 by 24), getting 5 as the quotient. We then annex 5 to the root and also to the trial divisor 24: etc.

172. In obtaining the *second* figure of the root by division we sometimes get a quotient which is too large. In such a case we find the root-figure by trial, as in the two following examples.

```
(i)     2̇25̇ ( 15
        1
   25 ) 125
        125
```

Here, dividing 12 by 2, the quotient is 6. Taking 6 as the required figure we find that the product (25×6) is greater than 125. We then take 5 which is found to be the required root-figure.

```
(ii)    3̇61̇ ( 19
        1
   29 ) 261
        261
```

Here, division gives 13 which is obviously inadmissible. By trial we find 9 to be the required root-figure.

* *N. B.* Each period consists of the figure over which a dot is placed and the figure to its left. Here the first period is 31 and second 36. The *first* period may consist of only one figure.

173. When the trial divisor is greater than the number to be divided by it (or when the quotient is 1 but found too large) we set down 0 in the root, annex 0 to the divisor, bring down the next period, and proceed in the usual way. The two following examples are given for illustration.

```
(i)        41209 ( 203              (ii)        4401604 ( 2098
           4                                    4
     403 ) 1209                           409 ) 4016
           1209                                 3681
                                         4188 ) 33504
                                                33504
```

174. In the process of extracting the square root, a remainder is often left, which is greater than the divisor. In the following example the second remainder 35 is greater than the divisor 29.

```
        39601 ( 199
        1
   29 ) 296
        261
  389 )  3501
         3501
```

EXAMPLES. 106.

1.	441.	**2.**	576.	**3.**	729.	**4.**	961.
5.	1024.	**6.**	6561.	**7.**	5625	**8.**	9216.
9.	27225.	**10.**	54756.	**11.**	49284.	**12.**	18225.
13.	119025.	**14.**	193600.	**15.**	646416.	**16.**	717409.
17.	4937284.	**18.**	2819041.	**19.**	1002001.	**20.**	1522756.
21.	82264900.	**22.**	625048836.	**23.**	97535376.	**24.**	21224449.

25. 3226694416. **26.** 6407522209 **27.** 236144689.

28. 360117609604. **29.** 295066240000. **30.** 15241578750190521.

31. A certain number of men spent R1681, each spending as many rupees as there were men ; how many men were there ?

32. A certain number of persons agree to subscribe as many pies each as there are subscribers ; the whole subscription being R33. 5a. 4p. How many subscribers were there ?

33. A gardener plants an orchard with 5776 trees and arranges them so that the number of rows of the trees equals the number of trees in each row. How many rows were there ?

34. A general having 11025 men under him, arranges them into a solid square. Find the number of men in the front.

35. A general wishing to arrange his men, who were 63510 in number, into a solid square, found that there were 6 men over. How many men were there in the front ?

36. Find the least integer which must be subtracted from 4230 in order to become a perfect square.

175. When a number, which is a perfect square, can be easily separated into prime factors, its square root may be found by inspection.

Thus $\sqrt{8100}=\sqrt{2^2\times5^2\times3^2\times3^2}=2\times5\times3\times3=90.$

Example. What is the smallest whole number by which 1260 must be multiplied in order to become a perfect square ?

Since $1260=2^2\times3^2\times5\times7$, $\therefore$ the number required $=5\times7=35$.

EXAMPLES. 107.

Find, by factors, the square root of

1. 900.	**2.** 1600.	**3.** 324.	**4.** 576.
5. 1296.	**6.** 4096.	**7.** 1764.	**8.** 7056.
9. 11025.	**10.** 53361.	**11.** 99225.	**12.** 571536.

13. $27\times12\times14\times56$. **14.** $182\times77\times66\times39$.

15. $609\times290\times165\times154$.

16. Find the smallest whole number by which 450 must be multiplied in order to become a perfect square.

17. Find the least number by which 2940 must be multiplied in order to become a perfect square.

18. Find the least number by which 968 must be divided in order to become a perfect square.

19. Find the least square number which is divisible by 10, by 16 and by 24.

20. What must be the least number of soldiers in a regiment, that will allow it to be drawn up 10, 15 or 25 deep, and also to be formed into a solid square ?

176. *To find the square root of a Decimal Fraction.*

To find the square root of a decimal fraction we proceed as in the case of a whole number. In pointing, the first point must be

placed or supposed to be placed on the units' figure. In the root the decimal point must be placed immediately after the root-figures corresponding to the integral part of the number.

We observe that if any decimal be squared there will be an even number of decimal places in the result. Consequently a decimal fraction (in its simplest form) to be a perfect square must have an even number of decimal places, and the number of decimal places in the root must be one-half of the number in the square.

If the given decimal is not a perfect square (which is always the case when the decimal in its simplest form contains an odd number of decimal places) the square root will be a non-terminating decimal; and we can find the square root to any number of decimal places we like.

In finding the square root of a decimal, the number of decimal places in it must be made *even*, by annexing ciphers, if necessary.

Example 1. Find the square roots of 11·9025 and ·5625.

```
       11·9025 ( 3·45   Ans.
        9
 64 )  290
       256
685 ) 3425
      3425
```

```
   ·5625 ( ·75   Ans.
    49
145 ) 725
      725
```

Example 2. Find the square root of ·045 to three places of decimals.

Here, we are to have three decimal places in the root; therefore in the given number, we make the decimal places *six*.

```
     ·045000 ( ·212...   Ans.
      4
 41 ) 50
      41
422 ) 900
      844
       56
```

Example 3. Find the square root of 3 to two places of decimals.

```
      30000 ( 1·73...   Ans.
      1
 27 ) 200
      189
343 ) 1100
      1029
        71
```

EXAMPLES. 108.

Find the square root of

1. 11·56. 2. 4·7089. 3. 39·0625. 4. 82·4464.
5. ·0064. 6. ·005329. 7. 1082·41. 8. 5·774409.
9. ·00053361. 10. ·00002025. 11. 236·144689. 12. ·804609.
13. ·000003418801. 14. 1·002001. 15. 938703·06991561.

Find to four places of decimals the square root of

16. 761·9. 17. 17. 18. 237·615. 19. 5. 20. 876·535.
21. ·1. 22. ·5. 23. 23·1. 24. ·9. 25. 20.
26. ·016. 27. ·00064. 28. 7. 29. 66. 30. 13.

177. *To find the square root of a Vulgar Fraction.*

The square root of a vulgar fraction is the square root of its numerator divided by the square root of its denominator.

Example 1. $\sqrt{\frac{16}{25}} = \frac{\sqrt{16}}{\sqrt{25}} = \frac{4}{5}$.

Example 2. $\sqrt{2\frac{1}{4}} = \sqrt{\frac{9}{4}} = \frac{\sqrt{9}}{\sqrt{4}} = \frac{3}{2} = 1\frac{1}{2}$.

Example 3. $\sqrt{\frac{3}{4}} = \frac{\sqrt{3}}{\sqrt{4}} = \frac{1{\cdot}73\ldots}{2} = {\cdot}86\ldots$

If the denominator be not a perfect square it is advantageous to make it so by multiplication.

Example 4. $\sqrt{\frac{1}{6}} = \sqrt{\frac{1\times6}{6\times6}} = \frac{\sqrt{6}}{\sqrt{36}} = \frac{2{\cdot}449\ldots}{6} = {\cdot}408\ldots$

Example 5. $\sqrt{\frac{5}{18}} = \sqrt{\frac{10}{36}} = \frac{\sqrt{10}}{\sqrt{36}} = \frac{3{\cdot}1622\ldots}{6} = {\cdot}5270\ldots$

Note. The square root of a fraction can also be found by reducing the fraction to a decimal and then extracting the square root of the decimal.

EXAMPLES. 109.

Find the square root of

1. $\frac{100}{1521}$. 2. $5513\frac{1}{16}$. 3. $32\frac{1}{9}$. 4. $101\frac{1}{400}$. 5. $\frac{8}{4\frac{1}{2}}$.
6. $2{\cdot}\dot{7}$. 7. $28{\cdot}\dot{4}$. 8. $3{\cdot}36\dot{1}$. 9. $8{\cdot}02\dot{7}$. 10. ${\cdot}07\dot{1}$.

Find to 3 places of decimals the square root of

11. $\frac{3}{4}$. 12. $\frac{5}{7}$. 13. $\frac{2}{3}$. 14. $\frac{5}{8}$. 15. $\frac{7}{12}$.

16. $\dot{3}$. **17.** $\cdot 41\dot{6}$ **18.** $\dfrac{1\cdot 2\dot{3}}{\cdot\dot{5}}$. **19.** $\dfrac{1}{\cdot\dot{2}\dot{5}}$. **20.** $\dfrac{5\cdot 04}{\cdot 01\dot{2}}$.

21. Simplify $\sqrt{(75\tfrac{1}{9})} \times \sqrt{(1\cdot\dot{7})} \div \sqrt{(2\tfrac{34}{81})}$.

178. When *more than half* the number of figures of a square root has been obtained by the ordinary method, the remaining figures may be obtained by division only.

Example 1. To find the square root of 189475225.

Here we find the first three figures in the ordinary way. To find the remaining two figures by division, we take twice the part of the root already found, as the divisor; we bring down one figure to the last remainder and divide; then to the new remainder bring down the next figure and divide The quotient thus obtained gives the two remaining figures of the root.

```
        1̇8̇9̇4̇7̇|5̇2̇2̇5̇(137|65 Ans.
        1
  23 )  89
        69
 267 )  2047
        1869
 274 )   1785 ( 65
         1644
          1412
          1370
            42
```

Note. Of course this process does not show whether the given number is a perfect square or not, but it is very useful in cases like the following.

Example 2. Find the square root of 2 to seven places of decimals.

Here we find 5 figures of the root by the ordinary method and the remaining three by division.

```
          2·   (1·4142|135.... Ans.
          1·
    24 )  100
           96
   281 )    400
            281
  2824 )    11900
            11296
 28282 )     60400
             56564
  28284 )     38360 ( 135
              28284
              100760
               84852
               159080
               141420
                17660
```

EXAMPLES. 110.

Find to 6 places of decimals the square root of

1.	5.	**2.**	17.	**3.**	761·9.	**4.**	·0003841.
5.	$\frac{3}{8}$.	**6.**	3.	**7.**	·07.	**8.**	·85.
9.	7619.	**10.**	$\frac{1}{8}$.	**11.**	237·615.	**12.**	·17.
13.	$\frac{5}{7}$.	**14.**	23·8369.	**15.**	·000943.	**16.**	10.

XXXI. CUBE ROOT.

179. A number is called the **cube root** of its cube. Thus 2 is the cube root of 8 ; 3 is the cube root of 27.

The cube root of a number is indicated by the symbol $\sqrt[3]{\ }$ placed before it. Thus $\sqrt[3]{8}$ indicates the *cube root of* 8, *i. e*, 2.

A number whose cube root can be expressed exactly either by a whole number or by a fraction is called a **perfect cube.**

The cubes of	1,	2,	3,	4,	5,	6,	7,	8,	9,
are respectively	1,	8,	27,	64,	125,	216,	343,	512,	729.

[These results should be committed to memory.]

180. The method of finding the cube root of a number is as follows :

Example 1. Find the cube root of 13824.

$$\begin{array}{rl}
 & 1\dot{3}82\dot{4}\ (\ 24\ \textit{Ans.} \\
 & 8 \\
\hline
2^2\times300=1200 & 5824 \\
2\times30\times4=\ \ 240 & \\
4^2=\ \ \ 16 & \\
\hline
1456 & 5824 \\
\hline
\end{array}$$

We divide the number into periods of 3 figures each, the number of dots indicating the number of figures in the cube root.

We find that **2** is the highest number whose cube is less than the first period ; this then is the first figure of the root. We subtract the cube of 2 from the first period and to the remainder we bring down the second period.

Next, we multiply the square of 2 (the first figure of the cube root) by 300 and set down the product 1200 ; this is the *trial divisor.* Dividing 5824 by this, the quotient is **4** : this is the second figure of the root. Now we multiply the first figure of the cube root by 30 and this product by the second figure of the root, and set down

the result under the trial divisor; then set down under this the square of the second figure of the cube root. Adding these three we get 1456 as our divisor. We then multiply this by the second figure of the root and subtracting the product from 5824 we find that there is no remainder. Therefore we conclude that 24 is the cube root of 13824.

If the cube root contains three or more figures the above process must be repeated.

Example 2. Find the cube root of 33076161.

Process : 33076161 (321 *Ans.*

			27
$3^2 \times 300$	=	2700	6076
$3 \times 30 \times 2$	=	180	
2^2	=	4	
		2884	5768
$32^2 \times 300$	=	307200	308161
$32 \times 30 \times 1$	=	960	
1^2	=	1	
		308161	308161

Note. Remarks of Arts. 172, 173 and 174 with regard to the process of extraction of the square root apply equally to the process of extraction of the cube root.

EXAMPLES. III.

Find the cube root of

1. 1331. **2.** 15625. **3.** 46656. **4.** 110592.
5. 117649. **6.** 373248. **7.** 2197. **8.** 185193.
9. 704969. **10.** 912673. **11.** 15069223. **12.** 105823817.
13. 843908625. **14.** 8737228816. **15.** 219365327791.
16. 167284151. **17.** 731189187729. **18.** 10970645048.
19. 93162981941037. **20.** 137174210836762689020631.

181. A decimal fraction (in its simplest form) to be a perfect cube must have 3, 6, 9,... decimal places; that is, the number of decimal places in it must be some multiple of 3. If the number of decimal places be not a multiple of 3, the cube root can be obtained to any number of decimal places we like. In extracting the cube root of a decimal, the number of decimal places must be made a multiple of 3 by annexing ciphers, if necessary.

The cube root of a vulgar fraction is the cube root of its numerator divided by the cube root of its denominator.

EXAMPLES. 112.

Find the cube root of

1. 17·576.	2. 132·651.	3. ·493039.
4. 64481·201.	5. 18·609625.	6. ·007645373.
7. ·876467493	8. ·001030301.	9. $\frac{64}{343}$.
10. $\frac{729}{140608}$.	11. $49\frac{8}{27}$.	12. $7558\frac{197}{512}$.
13. $\cdot\dot{0}3\dot{7}$.	14. $1587\cdot9\dot{6}\dot{2}$	15. $3845\cdot\dot{2}9\dot{6}$.
16. $40\frac{82}{125}$.	17. $20\frac{51}{64}$.	18. $\cdot2\dot{3}7\dot{0}$.

Find to three places of decimals the cube root of

19. 3·539	20. 11.	21. 24.	22. 7·52.	23. ·8.
24. ·27.	25. $\frac{1}{10}$.	26. $\frac{1}{6}$	27. ·0047.	28. $5\frac{4}{9}$.

182. When at least *one more than half* the number of figures in the cube root of a number has been found by the ordinary method, the remaining figures of the root may be found by division only.

Note. In this case we take for the divisor 300 times the square of the part of the cube root already obtained and proceed exactly as in Art. 178.

EXAMPLES. 113.

Obtain to 6 places of decimals the cube root of

1. 3·539.	2. 24.	3. 7·52.
4. ·002.	5. ·003.	6. $18\frac{7}{12}$.

183. The **fourth root** of a number is found by taking the square root of the square root of the number.

The **sixth root** of a number is found by taking the cube root of the square root of the number.

The **ninth root** of a number is found by taking the cube root of the cube root of the number.

EXAMPLES. 114.

Find the fourth root of

1. 256.	2. 234256.	3. 1679616.	4. 1575·2961.

Find the sixth root of

5. 531441. **6.** 308·915776. **7.** 24794911296.

Find the ninth root of

8. 262144. **9.** 1953125. **10.** 3000.

XXXII. MEASUREMENT OF AREA.

184. In Arithmetic we consider the areas of **rectangles** only.

Example. The floor, the ceiling and each wall of an ordinary room ; a sheet of paper ; each side of an ordinary box or brick ; all these are rectangular surfaces.

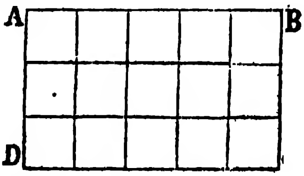
The length and breadth of a rectangle are called its **dimensions.**

185. The **unit of area** is a square whose side is the unit of length.

Area or **Surface** is measured by the number of units of area which it contains ; just as a length is measured by the number of units of length which it contains.

186. *To find the area of a rectangle.*

Let $ABCD$ be a rectangle, of which the length AB is 1 yd. 2 ft., and the breadth AD is 3 ft. Then, if the unit of length be a foot, the measure of AB is 5 and of AD is 3.



Divide AB and AD into 5 and 3 equal parts respectively, and through the points of division draw lines parallel to AD, AB respectively. Then the rectangle $ABCD$ is divided into 5×3 equal squares, the side of each of which is a foot in length.

Now, each of these squares is the unit of area ; therefore the *measure* of the area $ABCD$ (which is the same as the number of these squares) is 5×3 or 15.

$\therefore$ Area of $ABCD = 15$ sq. ft.

And generally, in any rectangle,

measure of area = measure of length × measure of breadth ;

or, more briefly,

area = length × breadth.

Whence,

length = area ÷ breadth ;

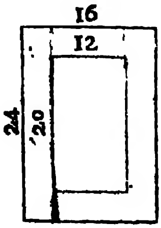
breadth = area ÷ length.

Note. A **square foot** is a square whose side is a foot. Note the difference between "3 **square feet**" and "3 **feet square**." *Three square feet* denotes an area 3 times as large as a square foot; *three feet square* denotes the area of a square whose side is 3 feet.

Example 1. Find the area of the floor of a room 10 ft. 6 in. long and 6 ft. 4 in. broad.

Length of room $=10\frac{1}{2}$ ft.;
breadth „ „ $=6\frac{1}{3}$ ft.;
area „ „ $=10\frac{1}{2}\times 6\frac{1}{3}$ sq. ft.
$=\frac{21}{2}\times\frac{19}{3}$ sq. ft.
$=\frac{133}{2}$ sq. ft.
$=66$ sq. ft. 72 sq. in.

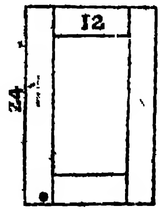
Example 2. A rectangular court, 24 yards long and 16 yards broad, has within it a path of uniform breadth of 2 yards running round it; find the area of the path.



Area of court $=24\times 16$ sq. yd.
$=384$ sq. yd.

The path takes off $(2+2)$ yd. from the length and $(2+2)$ yd. from the breadth;

$\therefore$ length of inner court $=20$ yd.,
and breadth ... ... $=12$ yd.;
$\therefore$ area ... ... $=20\times 12$ sq. yd.
$=240$ sq. yd.
$\therefore$ area of path $=(384-240)$ sq. yd.
$=144$ sq. yd.



Or thus:
Length of the path
$=(24\times 2+12\times 2)$ yd.
$=72$ yd.;
$\therefore$ the area of the path $=72\times 2$ sq. yd.
$=144$ sq. yd.

Example 3. Find the breadth of a courtyard 41 sq. ft. 80 sq in. in area, and 7 ft. 4 in. in length.

$$\text{Area} = \left(41 + \tfrac{80}{144}\right) \text{ sq. ft.}$$
$$= 41\tfrac{5}{9} \text{ sq. ft.};$$
$$\text{length} = 7\tfrac{1}{3} \text{ ft.}$$

$$\therefore \quad \text{breadth} = \frac{41\frac{5}{9}}{7\frac{1}{3}} \text{ ft.} = \frac{374}{9} \times \frac{3}{22} \text{ ft.} = 5\frac{2}{3} \text{ ft.}$$
$$= 5 \text{ ft. } 8 \text{ in.}$$

Example 4. How many paving stones, each 2 ft. 8 in. long and 17 in. wide, will cover the courtyard in *Ex.* 3?

$$\text{Area of court} = 41\tfrac{5}{9} \text{ sq. ft.};$$
$$\text{area of a stone} = 2\tfrac{2}{3} \times \tfrac{17}{12} \text{ sq. ft.} = \tfrac{34}{9} \text{ sq. ft.};$$

$$\therefore \quad \text{number of stones rqd.} = \frac{41\frac{5}{9}}{\frac{34}{9}} = \frac{374}{9} \times \frac{9}{34} = 11.$$

Example 5. Find the cost of matting the room in *Ex.* 1, at 3 annas per sq. ft.

The cost may be found by Practice or by Compound Multiplication.

EXAMPLES 115.

Find the area of the rectangles having the following dimensions:

1. 15 ft. by 12 ft.
2. 20 ft. by 16 ft.
3. 13 ft. 6 in. by 8 ft. 8 in.
4. 9 ft. 10 in. by 6 ft. 7 in.
5. 10 ft. $7\frac{1}{2}$ in. by 7 ft. $4\frac{1}{2}$ in.
6. 9 yd. 2 ft. by 7 yd. 1 ft.

Find the breadth of a room whose

7. area = 363 sq. ft., and length = 33 ft.
8. area = 6 sq. ft. 60 sq. in., and length = 2 ft. 9 in.
9. area = 5 ac. 1 ro. 36 po., and length = 267 yd. 2 ft.
10. area = 94 sq. yd. 8 ft. 84 in., and length = 32 yd. 1 ft. 8 in.
11. Find the area of a square field whose side is 32 ft. 8 in.
12. Find the area of a square room whose side is [illegible] yd. [illegible] ft. 3 in.
13. How many paving stones, each [illegible] ft. by [illegible], would be required to pave a square courtyard whose side is [illegible]?
14. How many pieces of carpet, each [illegible] ft. long and [illegible] wide, will cover the floor of a room 20 ft. by 13 ft. [illegible] in.?
15. Find the cost of carpeting a room [illegible] ft. 6 in. by [illegible] 6 in., at [illegible] per sq. ft.

16. Find the cost of polishing a marble slab, 3 ft. 3 in. by 2 ft. 6 in., at 2*d.* per sq. in.

17. A room, 20 ft. long, 16 ft. broad, has a stained border all round it 2 ft. wide ; what is the area of the stained part ?

18. A rectangular piece of ground is 88 yards long and contains an acre ; it consists of a walk 6 ft. wide surrounding a grass-plot : find the area of the walk.

19. How many stone slabs, 3 ft. long, 1 ft. wide, are requisite for paving a path which encloses a rectangular garden half a mile long and quarter of a mile wide, the path being 6 ft. wide ?

20. A gravel-path 5 ft. wide runs round a rectangular garden, 100 yd. by 75 yd. ; find the cost of making it at 4*a.* 6*p.* per sq. yd.

21. How many sq. yards of matting will be wanted to cover a room 31 ft. 6 in. by 22 ft. 6 in. ? What will be the cost at 4*d.* per sq. yd. ?

22. If 1200 stones, each 2 feet square, will pave a court, find the area of the court.

23. The cost of varnishing the floor of a room, 24 ft. long, at 2*s.* 6*d.* per sq. yd., is £5 ; find the breadth of the room.

24. A garden roller is 3 ft. 3 in. wide, and its circumference is 6 ft. 9 in. ; how many sq. ft. of ground does it pass over in one complete revolution ?

25. A sheet of paper is 20 in. long and 18 in. wide ; by how much must the width be narrowed to leave a surface of 2¼ sq. ft. ?

26. What length must be cut off a plank which is 5¼ in. broad, that the area may be a sq. foot ?

27. A factory has 100 windows, 60 of which severally contain 8 panes, each 9 in. by 6 in. ; and the remainder severally contain 10 panes, each 2 ft. square ; find the cost of glazing the whole at 10 annas per sq. ft.

28. What must be the length of a piece of land, 15 yards wide, that can be exchanged for a piece of the same quality, measuring 20 yards each way ?

29. Find the area of the square which has the same perimeter as a rectangle whose length is 48 ft. and is 3 times its breadth.

30. How many flag-stones, each 5·76 ft. long and 4·15 ft. wide, are requisite for paving a cloister, which encloses a rectangular court, 45·77 yd. long and 41·93 yd. wide, the cloister being 12·45 ft. wide ?

31. A room measuring 42 ft. 6 in. by 22 ft. 9 in. inside, with walls 2 ft. 3 in. thick, is surrounded by a verandah 10 ft. 6 in. wide. Find the cost of paving this verandah with tiles measuring 4½ in. by 3 in., and costing 6 pies each.

187. *Example* 1. Find the length of the side of a square which contains 91 sq. ft. 121 sq. in.

$$\text{Area} = 91 \text{ sq. ft. } 121 \text{ sq. in.} = 13225 \text{ sq. in.};$$

$$\therefore \text{ length of side} = \sqrt{13225} \text{ in.} = 115 \text{ in.}$$
$$= 9 \text{ ft. } 7 \text{ in.}$$

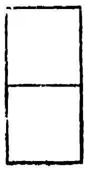
Example 2. Find the diagonal of a rectangular field, 16 yd. long and 12 yd. wide.

By Euclid I. 47,

$$\text{the diagonal} = \sqrt{16^2 + 12^2} \text{ yd.} = \sqrt{256 + 144} \text{ yd.}$$
$$= \sqrt{400} \text{ yd.} = 20 \text{ yd.}$$

Example 3. The area of a room which is twice as long as it is broad is 26 sq. yd. 8 sq. ft.; how long is it?

The room can be divided into two equal squares whose side is equal to the breadth of the room.



$$\text{Area of each square} = 13 \text{ sq. yd. } 4 \text{ sq. ft.}$$
$$= 121 \text{ sq. ft.};$$
$$\therefore \text{ side of each square} = \sqrt{121} \text{ ft.} = 11 \text{ ft.};$$
$$\therefore \text{ breadth of room} = 11 \text{ ft.} = 3 \text{ yd. } 2 \text{ ft.};$$
$$\therefore \text{ length of room} = 7 \text{ yd. } 1 \text{ ft.}$$

EXAMPLES. 116.

1. The area of a square field is 10 acres; find the length of its side.

2. The area of a square room is 502 sq. ft. 73 sq. in.; find the length of each side.

3. How many yards of fencing are required to enclose a square garden containing 4 ro. 1 po. 29 yd. $6\frac{3}{4}$ ft.?

4. A rectangular field is 40 yards long and 30 yards broad; find the distance from corner to corner.

5. What is the length of the diagonal of a square whose side is 4 yards?

6. The area of a square is 900 sq. ft.; what is the length of its diagonal?

7. The area of the floor of a room is 162 sq. ft.; its length is twice its breadth: find its length.

8. Find the length of a rectangular field which is 3 times as long as it is broad and which contains 768 sq. yd.

9. A room is half as long again as it is broad and its area is 69·36 sq. yd. ; find its perimeter.

10. The sides of two squares contain 77 yd. 1 ft. 6 in. and 7 yd. 2 ft. 4 in. respectively ; find the side of a square whose area is equal to the sum of the areas of the two squares.

188. Carpeting the floor and papering the walls of a room.

Example 1. Find the length of carpet $2\frac{1}{3}$ ft. wide, required for a room 28 ft. long, 20 ft. broad.

The carpet which will cover the floor of a room has the same area as the floor.

$$\text{Area of floor} = 28 \times 20 \text{ sq. ft.} ;$$

$$\therefore \text{ length of carpet reqd.} = \frac{28 \times 20}{2\frac{1}{3}} \text{ ft.} = \frac{28 \times 20 \times 3}{7} \text{ ft.}$$

$$= 240 \text{ ft.} = 80 \text{ yd.}$$

Example 2. Find the area of the four walls of a rectangular room 20 ft. long, 15 ft. broad and 10 ft. high.

The area of the four walls of a rectangular room is obtained by multiplying the circuit (*i. e.*, twice the sum of length and breadth) of the room by the height of the room.

$$\text{The circuit} = (20 + 15) \times 2 \text{ ft.} = 70 \text{ ft.} ;$$

$$\therefore \text{ the area of walls} = 70 \times 10 \text{ sq. ft.} = 700 \text{ sq. ft.}$$

To find the length of paper required to cover the walls, proceed as in the preceding example.

Note. In estimating the length of paper required, deductions for doors, windows and fireplaces must be made.

N.B. The cost of carpet or paper may be found by Practice or by Compound Multiplication.

EXAMPLES. 117.

Find the length of carpet required for rooms having the following dimensions :

1. Room, 25 ft. long, 18 ft. broad ; carpet, 2 ft. 6 in. wide.
2. Room, 20 ft. long, 12 ft. 6 in. broad ; carpet, 27 in. wide.
3. Room, $30\frac{3}{4}$ ft. long, $20\frac{1}{2}$ ft. broad ; carpet, 42 in. wide.

Find the expense of carpeting a room,

4. 16 ft. by 10 ft., with carpet 3 ft. wide, at Rs. 8a. a yard.

5. 30 ft. 9 in. by 25 ft., with carpet 30 in. wide, at 4*s.* 6*d.* a yard.

Find the area of the walls of the following rectangular rooms :

6. Length 20 ft., breadth 16 ft., height 9 ft.

7. Length 15 ft. 6 in., breadth 12 ft., height 9 ft.

8. Length 21 ft. 7 in., breadth 16 ft. 5 in., height $3\frac{1}{3}$ yd.

Find the length of wall paper required for the following rooms :

9. 25 ft. long, 20 ft. wide, 12 ft. high ; paper 15 in. wide.

10. 14 ft. long, 10 ft. wide, 7 ft. high ; paper 14 in. wide.

11. 27 ft. long, 18 ft. wide, 10 ft. high ; with paper 16 in. wide, allowing for 2 doors each 7 ft. by 4 ft.

12. 28 ft. long, 20 ft. broad, $9\frac{1}{2}$ ft. high ; with paper 20 in. wide, allowing for a door 6 ft. by $3\frac{1}{2}$ ft. and a window 3 ft. by $2\frac{1}{2}$ ft.

Find the expense of papering rooms whose dimensions are :

13. Length 21 ft., breadth 16 ft., height 10 ft. ; with paper 16 in. wide, at 4*a.* a yard.

14. Length 50 ft., breadth 35 ft., height 15 ft. ; with paper 15 in. wide, at 6*d* a yard.

15. Length 18 ft., breadth 16 ft., height 9 ft. ; with paper 15 in. wide, at 9*d.* a yard, allowing for 3 doors each 6 ft. by $3\frac{1}{2}$ ft., 2 windows 4 ft. by $2\frac{1}{2}$ ft., and a fireplace 6 ft. by 4 ft. 6 in.

16. How many yards will remain out of 300 yards of matting 2 ft. 6 in. wide, after covering two floors, each 25 ft. 6 in. by 21 ft ?

17. A square room whose floor measures 56 sq. yd. 2 sq. ft. 36 sq. in., is 10 ft. 4 in. high ; find the expense of whitewashing its ceiling and walls at 2*p.* per sq. yd.

18. The cost of covering the floor of a room, $12\frac{1}{4}$ yd. by $8\frac{3}{4}$ yd., with carpet $2\frac{1}{2}$ ft. wide, is £30. 14. $7\frac{1}{2}$; find the price of carpet per yard.

19. It costs £2. 5*s.* to paper a room 10 yd. long and 8 yd. wide, with paper $1\frac{1}{2}$ ft. wide, at 3*d.* per yard ; find the height of the room.

20. The cost of carpeting a room $16\frac{2}{3}$ ft. long and $12\frac{1}{4}$ ft. broad, with carpet at 6*s.* per yard, is £14. 17*s.* ; find the width of the carpet.

21. If a postage stamp be $\frac{7}{8}$ of an inch long and $\frac{3}{4}$ of an inch broad, what will be the cost of covering the walls of a room which is 15 ft. long, 12 ft. wide and 9 ft. high, with postage stamps, 6 pies each ?

22. What will be the cost of papering a room, 24 ft. long by 20 ft. broad and 8 ft. high, which has 2 doors each 7 ft. by 4 ft.,

with paper 2 ft. wide, at R4 a piece; the cost of putting it on being 4*a*. per piece, and each piece being 4 yards long?

23. The matting of a room, 3 times as long as broad, at 4 annas per sq. ft. cost R75; and the painting of the walls at 2 annas per sq. yd. cost R6. 6*a*. $2\frac{2}{3}$*p*.; what is the height of the room?

24. Find the expense of lining a cistern 10 ft. long, 8 ft. broad and 3 ft. deep, with lead at R10 per cwt., which weighs 5 lb. per sq. ft.

25. Find the cost of papering a room, 18 ft. long, 12 ft. broad and 10 ft. high, with paper 32 in. wide, at 6 annas a yard, allowing for a door 7 ft. by 4 ft., 3 windows each 4 ft. by 3 ft. and a panelling 2 ft. high round the floor.

26. A box with a lid is to be made of plank, one inch thick; the external dimensions are to be 18 in., 12 in., and 9 in.: how many sq. ft. of plank will be required?

27. The length of a room is $32\frac{1}{2}$ ft. The cost of papering the walls at R1. 14*a*. per sq. yd. is R308. 2*a*.; and the cost of carpeting the floor at R2. 4*a*. per sq. yd. is R150. 5*a*. Find the height and width of the room.

28. Find the cost of whitewashing the ceiling and the inner and outer sides of the walls of a room, 20 ft. long, 12 ft. wide and 15 ft. high, at 1 pie per sq. ft.; the walls being $1\frac{1}{2}$ ft. thick and 3 ft. higher at the outside.

LAND MEASUREMENT OF BENGAL.

189. If we have to find the area of a rectangular piece of land say, 14 bi. 3 cot. by 9 bi. 2 cot., we might proceed thus:

Area $= 14\frac{3}{20} \times 9\frac{1}{10}$ bi. (superficial) $= 128\frac{153}{200}$ bi. $=$ 128 bi. 15 cot. 4 ch. 16 ga.

But such examples are usually worked by the following rule:

Bigha multiplied by *bigha* gives *bigha*.
Bigha „ „ *cottah* „ *cottah*.
Cottah „ „ *cottah* „ *dhool*.

Twenty dhools make a *cottah*.

The truth of the rule will appear from the following considerations:

1 bi. × 1 bi. = 1 bi. (superficial);
1 bi. × 1 cot. $= 1 \times \frac{1}{20}$ bi. $= \frac{1}{20}$ bi. = 1 cot. (superficial);
1 cot. × 1 cot. $= \frac{1}{20} \times \frac{1}{20}$ bi. $= \frac{1}{20}$ cot. = 1 dhool.

By this method the above example will be worked thus :

We multiply all the terms of the 1st line (beginning with the lowest) by all the terms of the 2nd line (beginning with the highest).

bi.	cot.		
14 .	3		
9 .	2		
127 .	7		=(14 bi. 3 cot.) × 9 bi.
1 .	8 .	6	=(14 bi. 3 cot.) × 2 cot.
128 .	15 .	6	=(14 bi. 3 cot.) × (9 bi. 2 cot.)

∴ Area = 128 bi. 15 cot. 6 dhools

= 128 bi. 15$\frac{3}{10}$ cot.

= 128 bi. 15 cot. 4 ch. 16 ga.

EXAMPLES. 118.

Find the area of the following rectangular fields :

1. 4 bi. by 3 bi.

2. 10 bi. 10 cot. by 5 bi.

3. 12 bi. 15 cot. by 8 bi. 10 cot.

4. 14 bi. 8 cot. by 14 bi. 8 cot.

5. 24 bi. 8 cot. by 14 bi. 13 cot.

6. 57 bi. 5 cot. by 42 bi. 8 cot.

7. 99 bi. 19 cot. by 49 bi. 19 cot.

8. 115 bi. 14 cot. by 105 bi. 7 cot.

9. 8½ bi. by 3¼ bi.

10. 10¾ bi. by 15 cot.

11. 252 cubits by 164 cubits.

12. 408 cubits by 308 cubits.

XXXIII. MEASUREMENT OF SOLIDITY.

190. In Arithmetic we consider the volumes of **rectangular solids** only.

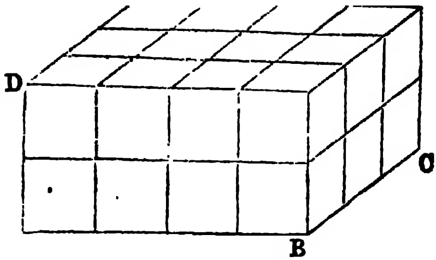
Example. A rectangular box, a brick, are rectangular solids.

The length, breadth and thickness (or height or depth) of a rectangular solid are called its **dimensions.**

191. The **unit of volume** is a cube each of whose edges is the unit of length.

Volume or **cubic content** is measured by the number of units of volume which it contains.

192. *To find the volume of a rectangular solid or rectangular parallelepiped.*



Let the annexed figure represent a rectangular parallelepiped, of which the length AB is 4 ft., breadth BC is 3 ft. and thickness AD is 2 ft. Divide AB BC, AD respectively into 4, 3 and 2 equal parts, and through the points of division draw planes parallel to the sides. Then the solid will be divided into a number of equal blocks, each of which is a *cubic foot*; and since there are two layers, in each of which there are 4×3 blocks, we see that there are $4 \times 3 \times 2$ blocks altogether, and the solid therefore contains $4 \times 3 \times 2$ cubic feet.

$\therefore$ The volume of the solid $= 4 \times 3 \times 2$ cu. ft.

And generally, in any rectangular solid,

The measure of volume = measure of length × measure of breadth × measure of thickness.

Or, more briefly,

Volume = length × breadth × thickness.

Whence, thickness = volume ÷ (length × breadth) : etc.

Example 1. Find the cubic content of a rectangular block of marble whose dimensions are 3 ft. 2 in., 2 ft. 3 in. and 1 ft. 6 in.

Volume $= 3\frac{1}{6} \times 2\frac{1}{4} \times 1\frac{1}{2}$ cu. ft. $= 10\frac{11}{16}$ cu. ft.

Example 2. How many bricks will be required to build a wall 20 ft. long, 10 ft. high and 2 ft. thick; each brick with its share of the mortar being 6 in. long, 3 in. wide and 2 in. deep?

$$\text{Number of bricks} = \frac{\text{volume of the wall}}{\text{volume of each brick}} = \frac{20 \times 10 \times 2}{\frac{1}{2} \times \frac{1}{4} \times \frac{1}{6}} = 19200.$$

Example 3. A rectangular cistern is 6 ft. long and 4 ft. broad; what is the depth of water in it, when it contains 72 cubic feet of water?

$$\text{Depth} = \frac{\text{volume of water}}{\text{area of the base}} = \frac{72}{6 \times 4} \text{ ft.} = 3 \text{ ft.}$$

Example 4. A box with a lid is to be made of half-an-inch plank; its internal dimensions are to be 20 in., 15 in. and 9 in. How many cu. in. of wood will be required?

The external demensions of the box are 21 in., 16 in. and 10 in.; $\therefore$ its external volume $= 21 \times 16 \times 10$ cu. in. $= 3360$ cu. in.; and its internal volume $= 20 \times 15 \times 9$ cu. in. $= 2700$ cu. in. $\therefore$ Volume of wood required for the box $= (3360 - 2700)$ cu. in $= 660$ cu. in.

We may obtain the area of the plank required by dividing the volume of the wood by the thickness of the plank.

EXAMPLES. 119.

Find the cubic contents of the rectangular solids having the following dimensions:

1. 10 ft., 8 ft., 5 ft. **2.** $7\frac{1}{2}$ ft., $5\frac{1}{4}$ ft., $4\frac{2}{3}$ ft.

3. 3 yd., 7 ft., 30 in. **4.** 5 ft 10 in., 3 ft., 6 in

5. 7 yd. 2 ft. 9 in., 6 yd. 1 ft. 3 in., 10 ft. 10 in.

6. Find the cubic content of a cube whose edge is $3\frac{1}{2}$ ft.

7. How many pounds of water will fill a cistern 2 yd. long, 3 ft. broad and 9 in. deep, having given that a cu. ft. of water weighs 1000 oz.?

8. How many bricks, each 9 in. by 6 in. by 4 in., are required for a wall 22 yd. long, 8 ft. high and 2 ft. 6 in. thick, leaving in it a doorway 6 ft. by 4 ft.?

9. How many times can a bucket, holding 2 cu. ft. of water, be filled from a tank 30 ft. long, 25 ft. wide and 10 ft. deep?

10. In what time will a cistern 16 ft. by 12 ft. by 10 ft., be filled by a pipe which discharges 40 cu. ft. of water per minute?

11. How many sheets, each 4 ft. long, 2 ft. broad and $\frac{1}{4}$ of an inch thick, can be made from 4 cu. ft. of iron?

12. Find the total weight of 27 sheets of copper, each 6 ft. long, 4 ft. broad and $\frac{1}{3}$ an inch thick, a cubic foot of copper weighing 2 cwt.

13. How many times can a pint-bottle be filled from a cistern 138·637 in. by 70 in. by 10 in., having given that a gallon contains 277·274 cubic inches?

14. A cu. inch of gold is hammered into a plate 6 in. square; find the thickness of the plate as the decimal of an inch.

15. Water is flowing into a reservoir which is 5 ft. square; how many cu. ft. of water will have flown in when the depth of water is $2\frac{1}{2}$ ft.?

16. A cistern, 12 ft. long and 8 ft. 6 in. broad, contains water; how many cu. ft. of water must be drawn off to make the surface sink half an inch?

17. A room, 40 ft. $10\frac{1}{2}$ in. by 25 ft. 8 in., accommodates 100 persons; what must be the height of the room if each person has $175\frac{2831}{3200}$ cu. ft of air?

18. What length must be cut off a rectangular marble slab, $1\frac{1}{2}$ ft. broad and 8 in. thick, in order that it may contain 2 cu. ft.?

19. Find the cost of digging a canal 1 mile long, 6 ft. wide and 5 ft. deep, at 4 annas per cu. yd.

20. A lake, whose area is 30 acres, is covered with ice 6 inches thick; find the weight of the ice in tons, if a cubic foot of ice weigh 900 oz. avoir.

21 There are 1530 cu. ft. of air in a room 9 ft. high; find the cost of carpeting it at Rs 1 per sq. ft.

22. A square room, 10 ft. high, contains 4000 cu. ft. of air; how many yards of paper, 2 ft. wide, will be required for covering its walls?

23. A solid stack, 41 ft 8 in. by 16 ft. 8 in. by 14 ft. 7 in., contains 125000 bricks, each 10 in. long and $3\frac{1}{2}$ in. thick; find the width of each brick.

24. A piece of ground is 100 yd. long and 75 yd. wide. To what uniform depth must it be excavated that the earth taken out may form an embankment of 25000 cubic yards, supposing the earth to be increased one-ninth in volume by removal?

25. A box (with cover) is made of an-inch-and-a-half plank; its external dimensions are 4 ft., 3 ft. 6 in. and 2 ft. 3 in.: find the weight of the box, supposing a cu. ft. of the wood to weigh 36 lb.

26. The roof of a verandah is supported by 16 teak beams, each 9 ft. long, 3 in. broad and 5 in. deep. If the weight of a cubic inch of teak is [illegible] of that of a cubic inch of water, and if a cubic foot of water weighs 1000 oz., find the weight in lbs. of the timber in the verandah.

27. A crow wishing to quench its thirst came to a vessel which contained 23 cu. in. of water. The crow being unable to reach the water, picked up several small stones, each three quarters of a cubic inch in size, and let them drop into the vessel until the water came to the top of the vessel. If the size of the vessel was such that it would exactly hold 73 cubic inches of water, find the number of stones dropped in by the crow.

28. The top of a tank is a rectangle whose sides are 15 ft. and 9 ft.; it is of the same horizontal section throughout its depth. What must be its depth in order that it may contain 12960 gallons of water, one gallon containing 277·274 cubic inches?

29. A moat is to be dug all round a rectangular fort, 200 yd. long and 150 yd. broad; it is to have vertical sides and to be 27 ft.

wide and 10 ft. deep throughout. Find the cost of digging it at 4 annas per cubic yard.

30. A room, 21 ft. long by $13\frac{1}{2}$ ft. wide, is surrounded by walls $1\frac{1}{2}$ ft. thick and 14 ft. high. There are two doors each $4\frac{1}{2}$ ft. by 6 ft., and one window 3 ft. by $4\frac{1}{2}$ ft. Find (i) the cost of building the walls at the rate of Rs. *1a.* per cubic yard, and (ii) the number of bricks, each measuring 9 in. by 4 in. by $2\frac{1}{4}$ in., required for the work.

XXXIV. DUODECIMALS.

193. Duodecimals or **Cross Multiplication** is a method (similar to that of Art. 189) of finding areas and volumes, made use of by painters, bricklayers, etc., in measuring work.

In duodecimals, the successive linear units are named and counted as follows :

1 foot = 12 *primes* ; 1 prime = 12 *seconds* ; 1 second = 12 *thirds* ; etc.

Note. A prime = an inch. A second is often called a *part.*

The successive superficial and solid units are named and counted exactly in the same way as the linear units : Thus,

1 superficial foot = 12 superficial primes : 1 supl. prime = 12 supl. seconds ; etc.

1 solid foot = 12 solid primes ; 1 solid prime = 12 solid seconds ; etc.

Primes, seconds, thirds, etc., are indicated by the accent (′), (″), (‴), etc., respectively.

The whole of the above statement may be briefly put thus :

$$\left.\begin{array}{l}1 \text{ linear foot}\\1 \text{ square foot}\\1 \text{ cubic foot}\end{array}\right\} = 12' = 144'' = 1728''' = 20736^{iv} = \text{etc.}$$

194. We can easily convert quantities expressed in duodecimals to those expressed in feet and inches, and conversely ; remembering that in linear measure the *inch* is the same as the *prime*, in square measure, as the *second*, and in cubic measure, as the *third.*

Example 1. 2 ft. $3'\,.\,4'' = 2$ ft. $3'\frac{4}{12} = 2$ ft. $3\frac{1}{3}$ in.

Example 2. 3 sq. ft. $2'\,.\,4''\,.\,3''' = 3$ sq. ft. $28''\frac{3}{12} = 3$ sq. ft. $28\frac{1}{4}$ in.

Example 3. 7 cu. ft. $1'\,.\,2''\,.\,5'''\,.\,6^{iv} = 7$ cu. ft. $173'''\frac{6}{12}$
$= 7$ cu. ft. $173\frac{1}{2}$ in.

Conversely,

Example 4. 4 yd. 3 ft. $2\frac{1}{3}$ in. $= 15$ ft. $2'\frac{1}{3} = 15$ ft. $2'\,.\,4''$.

Example 5. 2 sq. ft. $19\frac{2}{3}$ in. $=$ 2 sq. ft. $19''\frac{2}{3}$ $=$ 2 sq. ft. $1' . 7'' . 8'''$.

Example 6. 11 cu. ft. $1000\frac{1}{4}$ in. $=$ 11 cu. ft. $1000'''\frac{1}{4}$
$=$ 11 cu. ft. $83'' . 4'''\frac{1}{4}$ $=$ 11 cu. ft. $6' . 11'' . 4''' . 3^{iv}$.

EXAMPLES. 120.

Express in yards, feet and inches :

1. 12 ft. $7' . 5''$. **2.** 20 ft. $8' . 3'' . 9'''$.

3. 13 sq. ft. $9' . 3''$. **4.** 22 sq. ft. $3' . 4'' . 8'''$.

5. 40 sq. ft. $1' . 0'' . 3'''$. **6.** 2 sq. ft. $2' . 2'' . 2''' . 2^{iv}$.

7. 30 cu. ft. $3' . 4''$. **8.** 74 cu. ft. $7' . 3'' . 4'''$.

9. 10 cu. ft. $2' . 1'' . 0''' . 4^{iv}$. **10.** 3 cu. ft. $3' . 3'' . 3''' . 3^{iv} . 3^{v}$.

Express in duodecimals :

11. 2 yd. 2 ft. 7 in. **12.** 11 yd. 1 ft. $7\frac{1}{2}$ in.

13. 8 ft. $11\frac{5}{9}$ in. **14.** 10 ft. $9\frac{7}{8}$ in.

15. 6 sq. yd. 2 ft. $71\frac{1}{2}$ in. **16.** 7 sq. yd. 7 ft. $60\frac{3}{8}$ in.

17. 2 cu. yd. 8 ft. $150\frac{2}{3}$ in. **18.** 1 cu. yd. 1 ft. $240\frac{4}{9}$ in.

195. The following statements can be proved as in Art. 189.

Feet	into	primes	give	(supl.)	primes ;
"	"	seconds	"	"	seconds ;
"	"	thirds	"	"	thirds ; etc.
Primes	"	primes	"	"	seconds ;
"	"	seconds	"	"	thirds ; etc.
Seconds	"	seconds	"	"	fourths ;
"	"	thirds	"	"	fifths ; etc.

Also

(Supl.) feet	into	primes	give	(solid)	primes ;
" "	"	seconds	"	"	seconds ; etc.
" primes	"	primes	"	"	seconds ;
" "	"	seconds	"	"	thirds ; etc.

Example 1. Find the area of a rectangle 7 ft. 8 in. by 6 ft. 7 in.

We multiply all the terms of the multiplicand (commencing with the lowest) by all the terms of the multiplier (commencing with the highest).

ft.	'		
7	. 8		
6	. 7		
46	. 0		$=(7 \text{ ft. } 8') \times 6$ ft.
4	. 5	. 8	$=(7 \text{ ft. } 8') \times 7'$.
50	. 5	. 8	$=(7 \text{ ft. } 8') \times (6 \text{ ft. } 7')$.

Area $=$ 50 sq. ft. $5' . 8''$ $=$ 50 sq. ft. $68''$ $=$ 50 sq. ft. 68 in.

Example 2. Find the capacity of a cubical vessel whose edge is 2 ft. 3 in.

ft. ′		
2 . 3		
2 . 3		
4 . 6		= (2 ft. 3′) × 2 ft.
6 . 9		= (2 ft. 3′) × 3′.
5 . 0 . 9		= (2 ft. 3′) × (2 ft. 3′).
2 . 3		
10 . 1 . 6		= (5 sq. ft. 0′ . 9″) × 2 ft.
1 . 3 . 2	3	= (5 sq. ft. 0′ . 9″) × 3′.
11 . 4 . 8	3	= (5 sq. ft. 0′ . 9″) × (2 ft. 3′).

Capacity = 11 cu. ft. 4′ . 8″ . 3‴ = 11 cu. ft. 675‴ = 11 cu. ft. 675 in.

EXAMPLES 121.

Find by Cross Multiplication the areas of the following rectangles :

1. 3 ft. 4 in. by 2 ft. 3 in. **2.** 8 ft. 9 in. by 7 ft. 8 in.
3. 12 ft. 9 in. by 10 ft. 5 in. **4.** 16 ft. 11 in. by 12 ft. 10 in.
5. 20 ft. $7\frac{1}{2}$ in. by 15 ft. 4 in. **6.** 40 ft. 6 in. by 3 ft. $2\frac{1}{8}$ in.
7. 13 ft. $8\frac{5}{8}$ in. by 7 ft. $2\frac{1}{4}$ in. **8.** 12 ft. $9\frac{3}{4}$ in. by 10 ft. $2\frac{2}{3}$ in.
9. 24 ft. $6\frac{7}{8}$ in. by 9 ft. $3\frac{5}{8}$ in. **10.** 120 ft. $3\frac{1}{9}$ in. by 20 ft. $5\frac{5}{8}$ in.

Find the volumes of the following rectangular solids :

11. 4 ft. 7 in. by 3 ft. 9 in. by 2 ft. 3 in.
12. 6 ft. 8 in. by 5 ft. 7 in. by 3 ft. 5 in.
13. 10 ft. $8\frac{3}{4}$ in. by 9 ft. 6 in. by 8 ft. 7 in.
14. 12 ft. $3\frac{2}{3}$ in. by 7 ft. $4\frac{1}{4}$ in. by 5 ft. $2\frac{1}{2}$ in.
15. 20 ft. $7\frac{5}{9}$ in. by 15 ft. $8\frac{3}{8}$ in. by 10 ft. $2\frac{5}{8}$ in.

N. B. For additional examples, see the two preceding sections.

XXXV. PROBLEMS AND THE UNITARY METHOD.

196. When the value, weight or length, etc., of any number of units is given, we can, by *Compound Division*, obtain the value, weight or length, etc, of one of the units. And when the value, weight or length, etc., of one unit is given, we can, by *Compound Multiplication*, obtain the value, weight or length, etc., of any number of units of the same kind.

The solution by the application of the two above principles is called the **Unitary Method** or the **Method of Reduction to the Unit**. The method will be fully explained by the following examples.

107. *Example* 1. If 9 articles cost R36, what is the cost of 1 article?

The cost of 9 articles = R36.

∴ .... 1 article = R$\frac{36}{9}$

= R4. *Ans.*

Example 2. If 1 lb. of tea costs 2*s*. 6*d*., what will 8 lb. cost?

The cost of 1 lb = 2*s* 6*d*.,

∴ .... 8 ... = (2*s*. 6*d*.) × 8

= £1. *Ans.*

EXAMPLES. 122

1. If 7 articles cost R2. 10*a*., what is the cost of 1 article?

2. If 12 maunds of wheat cost R30, what will 1 maund cost?

3. If $7\frac{1}{2}$ yards of cloth cost R1. 14*a*., how much will 1 yd. cost?

4. If the weight of 16 equal bags of rice be 40 maunds, what is the weight of 1 bag?

5. If the length of a piece of cloth worth 18*s*. be 12 yards, what is the length of a piece of the same cloth worth 1*s*.?

6. If the rent of 13 acres of land is £4. 17*s*., what is the rent of 1 acre?

7. If the income-tax on R200 be R5 . 3 . 4, what is the tax on R1?

8. If 1 chair costs R2. 12*a*., how much will 13 chairs cost?

9. If 1 lb. of sugar costs 7*d*., what will 10 lb. cost?

10. If 1 bullock can plough $3\frac{1}{3}$ bighas in a day, how many bighas can 11 bullocks plough in a day?

11. If a man walk $3\frac{3}{4}$ miles in 1 hour, how far does he walk in $9\frac{1}{4}$ hours?

12. A servant's wages being 7*s*. 6*d*. per week, how much ought he to receive for 7 weeks?

13. If the railway fare for 1 mile is $2\frac{1}{2}$*p*., what is the fare for 24 miles?

14. If the carriage of 1 maund for 150 miles cost R2, what will be the cost of the carriage of $10\frac{1}{2}$ maunds for the same distance?

Example 3. If 5 men can do a piece of work in 3 days, how long will it take 1 man to do it?

5 men can do the work in 3 days,

∴ 1 man .... (3×5) days,

i. e., 15 days. *Ans.*

Example 4. If 1 man can do a piece of work in 21 days, in how many days can 3 men do it?

1 man can do the work in 21 days,

∴ 3 men .... $\frac{21}{3}$ days,

i. e., 7 days. *Ans.*

Note. In questions such as the two above, it should be noticed that to an **increase** in the number of workmen corresponds a **diminution** in the number of days, and *vice versa*.

EXAMPLES. 123.

1. If 10 men can do a piece of work in 3 days, how long will it take one man to do it?

2. If 12 men finish a piece of work in 5 days, in how many days could one man finish it?

3. If 3 maunds of rice last 9 persons 30 days, how long would they last 1 person?

4. If 7 cwt. can be carried 100 miles for 3*s.*, how far can 1 cwt. be carried for the same sum?

5. If 13 acres can be rented for 7 months for a certain sum, for how many months can 1 acre, be rented for the same sum?

6. If 1 man can do a piece of work in 40½ days, how long will it take 9 men to do it?

7. If 30 bushels feed 28 horses for a week, how many horses would they keep for 4 weeks?

8. If 1 man reap a field in 18 days, how long will 4 men be doing it?

9. A ship performs a voyage in 55 days, sailing 1 knot an hour, how many days would she take to perform the same voyage sailing 5 knots an hour?

10. If the carriages of 56 maunds for 1 mile cost a certain sum, how much will be carried 14 miles for the same money?

11. If 18 horses plough a field in 15 days, how many horses will plough it in 1 day?

12. If 18 horses plough a field in 15 days, in how many days will 1 horse plough it ?

13. If 1 horse can be kept 8 days for R2. 8*a*., for how many days can 4 horses be kept for the same sum ?

198. Each of the above questions requires either multiplication or division for its solution. In the following questions the two processes are combined.

Example 1. If 3 yards of cloth cost R4. 8*a*., what will be the cost of 35 yards ?

The cost of 3 yards = R4. 8*a*.,
∴ .... 1 yard = R4. 8*a*. × $\frac{1}{3}$,
∴ .... 35 yards = R4. 8*a*. × $\frac{35}{3}$,
= R52. 8*a*. *Ans.*

In multiplying by 35 *the method of multiplication by factors should be adopted.*

Example 2. How much must be paid for 17 maunds of sugar, when 8 maunds cost R74 ?

The cost of 8 maunds = R74,
∴ .... 1 maund = R74 × $\frac{1}{8}$,
∴ .... 9 maunds = R74 × $\frac{9}{8}$,
= R83. 4*a*. ;
∴ ....17 maunds = R157. 4*a*. (by addition).

Here we avoid the multiplication by 17 *which cannot be factorised.*

Example 3. If 6 maunds of wheat cost R7. 8*a*., how much can be purchased for R12. 8*a*. ?

R7. 8*a*. = 120*a*.
R12. 8*a*. = 200*a*.
120*a*. is the cost of 6 maunds,
∴ 40*a*. .... 2 ....,
∴ 200*a*. .... 10 .... *Ans.*

The artifice employed in this example should be carefully noted. We use here 40a. as the unit common to 120a. and 200a.

Example 4. If $\frac{3}{4}$ of an estate be worth R90, what is the value of $\frac{2}{3}$ of it ?

$\frac{3}{4}$ of the estate is worth R90,
∴ the estate is worth R90 × $\frac{4}{3}$,
∴ $\frac{2}{3}$ of the estate is worth R90 × $\frac{4}{3}$ × $\frac{2}{3}$ or R80. *Ans.*

Example 5. Express 1 mile in metres, 32 metres being equal to 35 yards.

35 yards = 32 metres,

$\therefore$ 5 yards = $\frac{32}{7}$ metres,

$\therefore$ 1760 yards = $\frac{32 \times 352}{7}$ metres or $1609\frac{1}{7}$ metres.

EXAMPLES. 124.

1. If 30 bullocks cost R810, what is the cost of 77 bullocks?

2. If 5 cwt. cost R6. 4a., what is the cost of 16 cwt.?

3. Find the value of 21 yd. of cloth when 4½ yd. cost R33.

4. If 7 pieces of cloth cost R350, what will 13 pieces cost?

5. If 13 reams of paper cost £6. 10*s*., what is the price of 21 reams?

6. If 23 copies of a book cost R35. 15*a*., how much will 31 copies cost?

7. If the cost of 60 eggs be 1*s*. 3*d*., how many can be purchased for 5*s*.?

8. How many oranges can be bought for R2. 3*a*. at the rate of 8*a*. 9*p*. a dozen?

9. If 4 cwt. cost £1. 1*s*. 1*d*., what will 2 tons 8 cwt. cost?

10. If 35 sheep produce 20 lb. of wool, what would 63 sheep produce?

11. If 42 men earn R3 . 4 . 6 for a day's work, what would 112 men earn?

12. If the railway fare for 100 miles be R3 . 8 . 6, what is the fare for 275 miles?

13. If 8 persons can be boarded for £3, how many can be boarded for £7. 10*s*.?

14. What is the value of 600 pins at the rate of 2*d*. per gross?

15. If $7\frac{3}{4}$ lb. cost 2*s*. 7*d*., what will $1\frac{1}{4}$ cwt. cost?

16. If $\frac{3}{4}$ of a maund cost R3. 12*a*., find the cost of $3\frac{3}{4}$ seers.

17. If $\frac{3}{7}$ of an estate be worth R2700, what is the value of $\frac{5}{8}$ of the estate?

18. If $\frac{7}{24}$ of a cargo be worth £357. 7*s*., what is the value of $\frac{3}{5}$ of the cargo?

19. The owner of ·375 of a ship sold $\frac{2}{3}$ of his share for R1040; find the value of ·875 of the ship at the same rate.

20. A man lost $\frac{2}{5}$ of his money, and then spent $\frac{3}{8}$ of the remainder; after which he had R120 left: how much did he lose?

21. A gentleman possessing $\frac{3}{14}$ of an estate sold $\frac{2}{7}$ of $\frac{5}{11}$ of his share for ₨241. 4*a.* ; what would ·2 of $\frac{3}{16}$ of the estate sell for at the same rate ?

22. If a man walk 46 miles in 3 days, in how many days will he walk 115 miles ?

23. If the rent of 34 acres is ₨21. 4*a.*, what is the rent of 51 acres ?

24. A servant's wages being £10. 8*s.* per annum, how much ought she to receive for 7 weeks ? [1 year = 52 weeks.]

25. A man's annual income is ₨4088 : what does he receive for 15 days ? [1 year = 365 days.]

26. If 27 bus. 2½ pk. cost £10. 7. 2¼, what is the cost of a bushel and a half ?

27. If 3 cwt. 3 qr. cost £6. 15*s.*, what will be the cost of 2 cwt. ?

28. A sack of potatoes weighs 89 seers ; if 6 such sacks cost ₨22. 4*a.*, what will be the cost of 22 seers ?

29. If 17 ac. 2 ro. 38 po. supply 3 horses, how many acres will supply 16 horses ?

30. If the carriage of 25 maunds for 500 miles cost ₨9. 6*a.*, what weight can be carried the same distance for ₨8 ?

31. If a piece of land worth ₨375 yield an income of ₨7. 8*a.*, what should be the value of a piece of land which yields an income of ₨18. 12*a.* ?

32. If 3⅔ acres can be mown in 7 days, how long will it take to mow 9⅓ acres ?

33. If 350 rupees weigh 9 lb, how many pounds will 625 rupees weigh ?

34. In a certain time the population of a town increased from 78960 to 82908 ; find by how many the population of another town of 92360 inhabitants would have increased at the same rate in the same time.

35. A man walks 4 miles in an hour ; how many yards does he walk in a minute ?

36. A railway train travels at the rate of 70 miles in 1½ hours ; find the rate per minute.

37. An express train goes 10 times as fast as a man who walks 6 ft. in a second : how many miles per hour does it go ?

38. Express 7½ miles in kilometres, 5 kilometres being equal to 5456 yards.

39. If 6½ grammes be equal to 105 grains, express a pound avoir. in grammes.

40. Convert £3 . 7 . 6 to Indian money, given R8 = 15*s*.

41. Convert 7 tons to maunds, given 35 seers = 72 lb.

42. Express $3\frac{1}{3}$ dollars in Indian money, 9 dollars being equal to 20 rupees.

43. If 8 horses eat as much as 6 oxen, how many oxen will eat as much as 20 horses?

44. If 4 men do as much work as 6 boys, how many men will do the work of 18 boys?

45. If the price of 7 horses and 5 oxen is R520, and that of an ox is R20, find the price of a horse.

46. If the weight of 5 rupees and 3 pice is 1200 grains, and that of a rupee is 180 grains, find the weight of a pice.

47. If 8 horses and 20 sheep eat the grass of 7 acres in a certain time, how many acres will feed 10 horses and 24 sheep for the same time, supposing a horse to eat as much as 4 sheep?

48. If 15 chairs and 2 tables cost R400, find the cost of 12 chairs and 3 tables, the cost of 10 chairs being equal to that of 4 tables.

49. If the wages of 4 men be equal to those of 5 women, what will 8 women earn in a day, the daily earnings of 10 men being R1. 9*a*.?

50. If a shop-keeper uses a weight of 15 oz. for 1 lb., how much will a customer lose in buying 24 lb.?

Example 6. If 35 men finish a piece of work in 8 days, how many men will finish it in 10 days?

In 8 days the work is done by 35 men,

∴ ... 2 .... 35×4 ......,

∴ ... 10 .... $\frac{35 \times 4}{5}$ ......,

or 28 men. *Ans.*

Example 7. If the penny loaf weighs 12 oz. when wheat is £4 a quarter, what should it weigh when wheat is £4. 16*s*. a quarter?

£4 = 80*s*. ; £4. 16*s*. = 96*s*.

When wheat is 80*s*. a qr. the loaf weighs 12 oz.,

∴ .... 16*s*. ....(12×5) oz.,

∴ .... 96*s*. .... $\frac{12 \times 5}{6}$ oz.,

or 10 oz. *Ans.*

Example 8. A garrison of 1200 men is provisioned for 60 days; if after 15 days 300 men leave the garrison, how long will the remaining provisions last the men left?

The provisions left would last 1200 men 45 days,

∴ they would last 300 men (45 × 4) days,

∴ they would last 900 men $\frac{45\times4}{3}$ days, or 60 days. *Ans.*

EXAMPLES. 125.

1. If 9 men can mow a field in 4 days, in how many days could 6 men mow the same field?

2. If 12 horses can plough a field in 7 days, in how many days could 14 horses plough it?

3. If 16 men finish a piece of work in 5 days, in how many days could 10 men do it?

4. If 25 men reap a field in 12 days, how many men could reap it in 20 days?

5. If 7 cwt. feed 15 horses for 8 days, how many horses would they feed 12 days?

6. If 28 maunds can be carried 50 miles for a certain sum, what weight can be carried 125 miles for the same sum?

7. If 16 bighas can be rented for 9 months for Rs10, for how many months can 36 bighas be rented for the same sum?

8. A man walks from Calcutta to Hugly in 6 hours, walking 4 miles an hour; how long would he take if he rode at the rate of 9 miles an hour?

9. If the twopenny loaf weighs 20 oz. when wheat is £4. 10*s.* a quarter, what should it weigh when wheat is £8 a quarter?

10. If the sixpenny loaf weighs 64 oz. when wheat is 6*s.* 9*d.* a bushel, what is the price of wheat per bushel when the sixpenny loaf weighs 48 oz.?

11. From a mass of silver I can make 64 plates weighing 3 oz. each, how many 4 oz. plates could I make from the same?

12. A garrison of 1200 men has provisions for 75 days; how long would they last if the garrison were reduced to 500 men?

13. A fortress is provisioned for 4 weeks at the rate of 20 oz. a day for each man: if only 12 oz. be served out daily for each man, how long can the place hold out?

14. A garrison of 1000 men is provisioned for 70 days: if after 20 days the garrison is re-inforced by 200 men, how long will the remaining provisions last?

15. If 7 men can mow a meadow in 7 days, working 10 hours

a day, how many additional hours a day must they work to do it in 5 days ?

16. If I borrow ₨300 for 8 months, for how long should I lend ₨400 in return ?

17. If it requires $27\frac{1}{2}$ yd. of carpet 9 in. wide to cover a room, how many yards of carpet 7 in. wide will be necessary to cover the same room ?

EXAMPLES. 126.

1. If 30 seers of corn feed 6 horses for 4 days, how many horses would they feed for 12 days ?

2. If 30 seers of corn feed 6 horses for 4 days, how many horses would 25 seers feed for the same time ?

3. If 30 seers of corn feed 6 horses for 4 days, for how many days would they feed 8 horses ?

4. If 30 seers of corn feed 6 horses for 4 days, for how many days would $52\frac{1}{2}$ seers feed the same number of horses ?

5. If 30 seers of corn feed 6 horses for 4 days, how many seers will feed 10 horses for the same time ?

6. If 30 seers of corn feed 6 horses for 4 days, how many seers will feed the same number of horses for 9 days ?

7. If 20 men reap a field of 6 acres in 40 hours, in how many hours will 35 men reap the same field ?

8. If 20 men reap a field of 6 acres in 40 hours, how many men will reap the same field in 25 hours ?

9. If 20 men reap a field of 6 acres in 40 hours, how many acres will 35 men reap in the same time

10. If 20 men reap a field of 6 acres in 40 hours, how many men will reap 15 acres in the same time ?

11. If 20 men reap a field of 6 acres in 40 hours, how many acres will they reap in 55 hours ?

12. If 20 men reap a field of 6 acres in 40 hours, in how many hours will they reap a field of 8 acres ?

13. When rice is ₨3 per md., how many people can be fed for the same sum that would feed 90 people when rice is ₨2. 8*a.* per md. ?

14. If a lb of flour cost 9*p.* when wheat is ₨3 per md., what should be the price of a md. of wheat when 1 lb. of flour costs 1*a.* ?

15. How many yards of cloth worth 4*a.* 6*p.* per yard must be given in exchange for 30 yards at 3*a.* 6*p.* per yard ?

16. Find the length of a strip of land 20 yd. wide, that should be given in exchange for a piece measuring 40 yd. by 30 yd.

17. If 3 lb. of tea cost as much as 10 lb. of sugar, how much tea should be given in exchange for 25 lb. of sugar?

18. A brewer receives 10 doz. of brandy in exchange for 4 barrels of ale worth £3. 10*s.* a barrel; what does the brandy cost him per bottle?

19. A man contracts to perform a piece of work in 20 days, and immediately employs upon it 16 men. At the end of 12 days the work is only half done; what additional number of men must he employ to fulfil the contract?

20. A merchant of Calcutta indented from London goods worth £640, and paid £10 for freight. If a rupee is equal to 1*s.* 9*d.*, for how many annas must he sell goods, for which he paid 1*s.* to the London manufacturer, in order to gain £50 on the whole outlay?

21. If a quantity of flour serve 36 men for 15 days at the rate of 12 oz. a day for each man, how many ounces a day will each man get, when the same quantity of flour serves 42 men for the same time?

22. When grain is R2 per md. how many horses can be kept for the same sum that would keep 20 horses when grain is R1. 8*a.* per md.?

Example 9. If 10 men can do a piece of work in 12 days, working 7 hours a day, how many hours a day must 6 men work to do the same in 14 days?

10 men can do the work in (12×7) hours,

∴ 2 .... $(12\times7\times5)$ ....,

∴ 6 .... $\frac{12\times7\times5}{3}$ ....;

∴ to complete the work in 14 days, they must work $\frac{12\times7\times5}{3\times14}$ hours, or 10 hours a day.

Example 10. If a number of men can dig a trench 210 yd. long, 3 wide and 2 deep, in 5 days of 11 hours each, in how many days of 10 hours each, will they dig a trench 420 yd. long, 6 wide and 3 deep?

$(210\times3\times2)$ cu. yd. is dug in 55 hours.

∴ 1 .... $\frac{55}{210\times3\times2}$ hours,

∴ $(420\times6\times3)$ .... $\frac{55\times420\times6\times3}{210\times3\times2}$ hours,

or 330 hours;

∴ the number of days required $=\frac{330}{10}=33$.

Example 11. If 8 oxen or 6 horses eat the grass of a field in 10 days, in how many days will 5 oxen and 4 horses eat it?

8 oxen eat as much as 6 horses,

$\therefore$ 1 ox eats .... $\frac{6}{8}$ horses,

$\therefore$ 5 oxen eat .... $\frac{6\times5}{8}$ horses, or $\frac{15}{4}$ horses;

$\therefore$ 5 oxen and 4 horses eat as much as $(\frac{15}{4}+4)$ horses or $\frac{31}{4}$ horses.

Now, 6 horses eat the grass in 10 days,

$\therefore$ 1 horse will eat .... 10×6 ......,

$\therefore$ $\frac{31}{4}$ horses .... $\frac{10\times6\times4}{31}$ ......,

or $7\frac{23}{31}$ days.

EXAMPLES. 127.

1. If 5 men can do a piece of work in 8 days, working [illegible] hours a day, how many men will do the same piece of work in $4\frac{2}{3}$ days, working 10 hours a day?

2. If 9 men can do a piece of work in 7 days, working 10 hours a day, how many hours a day must 6 men work to do the same in 30 days?

3. If 12 men can do a piece of work in 8 days of 7 hours each, in how many days of 6 hours each can 10 men do the same?

4. If 20 masons build a wall, 50 ft. long, 2 ft. thick and 14 ft. high, in 12 days, in how many days will they build a wall, 55 ft. long, 4 thick and 16 high?

5. If 20 men dig a trench, 100 yd. long, 5 wide and 3 deep, in 3 days, how many men will dig a trench 150 yd. long, 6 wide and 2 deep, in the same time?

6. If 5 men reap a rectangular field, 200 ft. by 50 ft., in 2 days of 10 hours each, in how many days of 8 hours each can they reap another, 300 ft. by 40 ft.?

7. If 6 men or 8 boys can do a piece of work in 18 days, in how many days will 3 men and 5 boys do it?

8. If 5 men, 7 women or 9 boys can dig a ditch in 15 days, in how many days can 1 man, 1 woman and 1 boy dig it?

9. 4 men do as much work as 6 boys in the same time, and a piece of work in which 20 men and 15 boys are engaged take 25 days; how many days would it take if 15 men and 20 boys were employed upon it?

10. If 10 gas-burners, which are lighted 4 hours every evening for 15 days, consume a quantity of gas which costs R3, for how many days can 12 burners be lighted 5 hours every evening at the same cost?

11. If a piece of matting, measuring 7 ft. 4 in. by 5 ft., cost R6. 14*a.*, what will be the cost of a piece of the same matting, measuring 10 ft. by 6 ft. 6 in.?

12. If the cost of printing a book of 250 pages, with 21 lines on each page, and on an average 10 words in each line, be R125, find the cost of printing a book of 300 pages, with 14 lines on each page and 8 words in each line.

13. If 8 men, working 7 hours a day, take 12 days to complete a piece of work, how long will 14 boys, working 6 hours a day, take to do the same work, the work of one man being equal to that of two boys in the same time?

14. If the feeding of 8 horses and 20 sheep for a month cost R100, what will be the cost of feeding 6 horses and 50 sheep for a month, supposing that 2 horses eat as much as 15 sheep?

BANKRUPTCIES, RATING, TAXING, ETC.

199. *Example* 1. A bankrupt's debts are R7240, and his assets (*i. e.*, the value of his property) are R5430; how much can he pay in the rupee?

In the place of R7240 he can pay R5430,

∴ .... R1 .... R$\frac{5430}{7240}$, or R$\frac{3}{4}$,

or 12 annas;

∴ he can pay 12*a.* in the rupee.

Example 2. A bankrupt's debts amount to £3720, and he pays 18*s.* in the pound: what are his assets?

In the place of £1 he pays 18*s.*,

∴ .... £3720 .... (3720 × 18)*s.*,

∴ his assets are (3720 × 18)*s.*, or £3348.

Example 3. A man pays an income-tax of R125 at the rate of 5*p.* in the rupee; find his income.

R125 = 24000*p.*

He pays 5*p.* on R1,

∴ .... 24000*p.* on R4800;

∴ his income is R4800.

Example 4. After paying an income-tax of 6*d.* in the pound a man has £780 left; find his gross income.

He has 19*s.* 6*d.* left out of £1,

∴ .... 1*s.* .... £$\frac{2}{39}$;

∴ .... (780 × 20)*s.* .... £$\frac{2\times780\times20}{39}$, or £800;

∴ his gross income is £800.

Example 5. A man pays an income-tax of 6*p*. in the rupee on $\frac{2}{3}$ of his income ; how much in the rupee does he pay on his whole income ?

He pays 6*p*. in the rupee on $\frac{2}{3}$ of his income, *i. e.*, he pays $\frac{6}{16\times12}$ of $\frac{2}{3}$ of his income, or $\frac{1}{48}$ of his income. But $\frac{1}{48}$ of R1 = 4*p*. ; ∴ he pays 4*p*. in the rupee on his whole income.

Example 6. When income-tax is 5*p*. in the rupee a person has to pay R20 more than when the tax was 4*p*. in the rupee ; find his income.

Difference of tax is 1*p*. when the income is R1.

∴ ....(20 × 16 × 12)*p*.................. R(20 × 16 × 12),

or R3840 ;

∴ his income is R3840.

EXAMPLES. 128.

1. Find the income-tax on R3600 at 5*p*. in the R.

2. How much will a poor-rate of 1*s*. 6*d*. in the £ produce in a parish where the whole property is rated at £3768. 8*s*. ?

3. Find the amount of road-cess. at 6*p*. in the R, on a rental of R5500.

4. A bankrupt's debts are R7880, and his assets R4925 ; how much in the rupee can he pay ?

5. A bankrupt's effects amount to R6131 . 5 . 4, and his debts are R36788 ; how much can he pay in the rupee ?

6. If a man has to pay £9 . 7 . 6 for income-tax on an income of £750, what is the rate of tax per £ ?

7. A bankrupt's debts are R3798, and he pays 12*a*. 6*p*. in the rupee ; what are his assets ?

8. A bankrupt's assets are £2900, and he pays his creditors 14*s*. 6*d*. in the £ : what do his debts amount to ?

9. A man pays an income-tax of R40 at the rate of 4*p*. in the rupee ; find his income.

10. If I pay £16. 10*s*. 6*d*. for income-tax, being at the rate of 10*d*. in the £, what is my income ?

11. After paying an income-tax of 5*p*. in the rupee a man has R2805 left ; find his gross income.

12. A person after paying 7*d*. in the £ for income-tax has £174. 15*s*. left ; what was his gross income ?

13. A creditor received 16*s*. 3*d*. in the £, and thereby lost £135. 10*s*. ; how much was due to him ?

14. A man pays an income-tax of $4p.$ in the rupee on $\frac{3}{4}$ of his income; what rate per rupee does he pay on his whole income?

15. A man pays an income-tax of $8p.$ in the rupee on $\frac{3}{8}$ of his income; what fraction of his whole income is paid as income-tax?

16. When the income-tax is $9d.$ in the pound a person has to pay £40 less than when the tax was $1s.$ in the pound; find his income.

17. When the income-tax is $7d.$ in the pound a person has to pay £25 more than when the tax was $5d.$ in the pound; find his income.

PROBLEMS RELATING TO WORK DONE IN A CERTAIN TIME.

200. *Example* 1. A can do a piece of work in 7 days, and B can do it in 9 days; how long will A and B, working together, take to do the work?

A can do the work in 7 days, $\therefore$ A can do $\frac{1}{7}$ of it in 1 day;
B .... 9 ......, $\therefore$ B .... $\frac{1}{9}$ .... ;
$\therefore$ A and B together can do $(\frac{1}{7}+\frac{1}{9})$ of it in one day,
$\therefore$ .... $\frac{16}{63}$. ....,
$\therefore$ .... the whole in $\frac{63}{16}$ days;
$\therefore$ the time required $=\frac{63}{16}$ days $=3\frac{15}{16}$ days.

Example 2. A and B together can perform a piece of work in 5 days, and A alone can do it in 8 days: what time will it take B to do it alone?

A and B can do the work in 5 days, $\therefore$ they can do $\frac{1}{5}$ of it in 1 day;
A alone .... 8 ...., $\therefore$ he .... $\frac{1}{8}$ .... ;
$\therefore$ B alone can do $(\frac{1}{5}-\frac{1}{8})$ of it in 1 day,
$\therefore$ .... $\frac{3}{40}$ ....,
$\therefore$ .... the whole in $\frac{40}{3}$ days, or $13\frac{1}{3}$ days. *Ans.*

Example 3. A vessel can be filled by a pipe in 25 minutes, and it can be emptied by a waste pipe in 20 minutes; if both the pipes be opened when the vessel is full, how soon will it be empty?

1st pipe fills $\frac{1}{25}$ of the vessel in 1 minute,
2nd pipe empties $\frac{1}{20}$ .... ;
$\therefore$ when both pipes are open
$(\frac{1}{20}-\frac{1}{25})$ of the vessel is emptied in 1 minute,
i. e., $\frac{1}{100}$ ....,
$\therefore$ the whole will be emptied in 100 minutes.

Example 4. *A* and *B* can do a piece of work in 5 hours ; *A* and *C* in 4 hours ; *B* and *C* in $3\frac{1}{2}$ hours. In what time can *A* alone do it?

A and *B* can do $\frac{1}{5}$ in 1 hour ;

A and *C* .... $\frac{1}{4}$ .... ;

$\therefore$ two men of *A*'s strength, and *B* and *C* can do

$\frac{1}{5}+\frac{1}{4}$ in 1 hour ;

but *B* and *C* can do $\frac{2}{7}$ in 1 hour ;

$\therefore$ two men of *A*'s strength can do $\frac{1}{5}+\frac{1}{4}-\frac{2}{7}$ in 1 hour,

or $\frac{23}{140}$ in 1 hour ;

$\therefore$ *A* can do $\frac{23}{280}$ in 1 hour ;

$\therefore$ *A* can do the whole in $\frac{280}{23}$ hours, or $12\frac{4}{23}$ hours. *Ans.*

Example 5. *A* does $\frac{4}{5}$ of a piece of work in 20 days ; he then calls in *B*, and they finish the work in 3 days : how long would *B* take to do the whole work by himself?

	A does	$\frac{4}{5}$	of the work in	20 days,
$\therefore$	*A* can do	$\frac{1}{25}$	of the work in	1 day,
$\therefore$	*A* does,	$\frac{3}{25}$	of the work in	3 days,
But	*A* and *B* do	$\frac{1}{5}$	of the work in	3 days,
$\therefore$	*B* does	$(\frac{1}{5}-\frac{3}{25})$	of the work in	3 days,
i. e.,	....	$\frac{2}{25}$	....	,
$\therefore$	*B* can do	$\frac{2}{75}$	....	1 day,

$\therefore$ *B* can do the whole work in $\frac{75}{2}$ days, or $37\frac{1}{2}$ days. *Ans.*

EXAMPLES. 129.

1. *A* can do a piece of work in 10 hours : *B* can do it in 8 hours. In what time will they do it if they work together?

2. If *A* does a piece of work in 4 days, which *B* can do in 5, and *C* can do in 6, in what time will they do it, all working together?

3. A cistern can be filled by one pipe in $3\frac{1}{2}$ hours, by a second in $3\frac{1}{5}$ hours, and by a third in $5\frac{1}{4}$ hours ; in what time will it be filled by all the three in action together?

4. *A* can reap a field in 10 days ; *B* can reap it in 12 days ; *C* can reap it in 15 days : how long will it take them all together to reap it, and what part of the work will be done by each?

5. *A* and *B* together can dig a trench in 4 days, and *A* alone can dig it in 6 days ; in how many days can *B* alone dig it?

6. Two pipes, *P* and *Q*, together can fill a cistern in 20 minutes, and *P* alone in 30 minutes : how long would *Q* alone take?

7. A vessel can be filled by one pipe in 8 minutes, by a second pipe in 10 minutes ; it can be emptied by a waste pipe in 12 minutes : in what time will the vessel be filled if all the three be opened at once ?

8. A vessel has 3 pipes connected with it, 2 to supply and 1 to draw off. The first alone can fill the vessel in $4\frac{1}{2}$ hours, the second in 3 hours, and the third can empty it in $1\frac{1}{2}$ hours. If all the pipes be opened when the vessel is half-full, how soon will it be empty ?

9. *A* and *B* can do a piece of work in 6 days ; *A* and *C* in $5\frac{1}{2}$ days ; *B* and *C* in 4 days. In what time could each do it ?

10. *A* and *B* can mow a field in $3\frac{1}{3}$ days ; *A* and *C* in 4 days ; *B* and *C* in 5 days. In what time could they mow it, all working together ?

11. *A* does $\frac{3}{8}$ of a piece of work in 9 days ; he then calls in *B*, and they finish the work in 6 days. How long would *B* take to do the whole work by himself ?

12. *A* does $\frac{7}{10}$ of a piece of work in 15 days ; he does the remainder with the assistance of *B* in 4 days. In what time could *A* and *B* together do it ?

13. *A* can do a piece of work in 16 days, *B* in 10 days ; *A* and *B* work at it together for 6 days, and then *C* finishes it in 3 days : in how many days could *C* have done it alone ?

14. *A* and *B* together can do a piece of work in 6 days, *B* alone could do it in 16 days. If *B* stops after 3 days, how long afterwards will *A* have finished the work ?

15. *A* and *B* can reap a field in 30 days, working together. After 11 days, however, *B* is called off, and *A* finishes it by himself in 38 days more. In what time could each alone do the whole ?

16. *A*, *B* and *C* together can do a piece of work in 6 days, which *B* alone can do in 16 days, and *B* and *C* together can do in 10 days : in how many days can *A* and *B* together do it ?

17. Five men can do a piece of work in 2 hours, which 7 women could do in 3 hours, or 9 children in 4 hours. How long would 1 man, 1 woman and 1 child together take to do the work ?

18. *A* can do a piece of work in 4 hours ; *B* and *C* can do it in 3 hours, *A* and *C* can do it in 2 hours. How long would *B* alone take to do it ?

19. *A* and *B* together can do a piece of work in 8 days : *B* alone can do it in 12 days ; supposing *B* alone works at it for 4 days, in how many more days could *A* alone finish it ?

20. Three taps, *A*, *B* and *C*, can fill a cistern in 10 min., 12 min. and 15 min. respectively. They are all turned on at once,

but after $1\frac{1}{2}$ min. B and C are turned off. How many minutes longer will A take then to fill the cistern ?

21. Two pipes, A and B, can fill a cistern in 3 hours and 4 hours respectively ; a waste pipe C can empty it in 2 hours ; if these pipes be opened in order at 7, 8 and 9 o'clock, find when the cistern will be filled.

22. A piece of work was to be completed in 40 days ; a number of men employed upon it did only half the work in 24 days ; 16 more men were then set on, and the work was completed in the specified time : how many men were employed at first ?

23. A can do a certain work in the same time in which B and C together can do it. If A and B together could do it in 10 days, and C alone in 50 days, in what time could B alone do it ?

24. A and B can do a piece of work in 10 days, B and C in 15 days, and A and C in 25 days : they all work at it together for 4 days ; A then leaves, and B and C go on together for 5 days more, and then B leaves : in how many more days will C complete the work ?

25. A cistern can be filled by two pipes in 30 and 40 minutes respectively ; both the pipes were opened at once but after some time the first was shut up, and the cistern was filled in 10 minutes more. How long after the pipes had been opened was the first pipe shut up ?

26. A cistern has 3 pipes, A, B and C ; A and B can fill it in 2 and 3 hours respectively ; C is a waste-pipe. If all the three pipes be opened at once $\frac{7}{24}$ of the cistern will be filled up in 30 minutes. In what time can C empty the full cistern ?

27. Forty men can finish a piece of work in 40 days ; but if 5 men leave the work after every tenth day, in what time will the whole work be completed ?

PROBLEMS RELATING TO CLOCKS.

201. *Example* 1. Two clocks are at 12 noon ; one gains 40 seconds and the other loses 50 seconds in 24 hours : after what interval will the one have gained 16 minutes on the other, and what time will each then show ? What will be the true time when the first clock indicates 3 P. M. on the following day ?

(i) The one clock gains on the other $(40+50)$ seconds in 24 hours ;

i.e., it gains $\frac{3}{2}$ min. in 1 day,

$\therefore$ .... 1 .... $\frac{2}{3}$ ....,

$\therefore$ .... 16 .... $\frac{2\times 16}{3}$ days, or $\frac{32}{3}$ days,

or 10 days 16 hours (true time).

(ii) Now in $\frac{32}{3}$ days the first clock gains $\frac{32}{3} \times 40$ sec. or $7\frac{1}{9}$ min., and the second loses $\frac{32}{3} \times 50$ sec. or $8\frac{8}{9}$ min.

But the correct clock, at the end of the interval (*i. e.*, 10 days 16 hours) will show 4 A. M.

Therefore the first will show 4 h. $7\frac{1}{9}$ min. A. M.;

and the second will show 3 h. $51\frac{1}{9}$ min. A. M.

(iii) From 12 noon to 3 P. M. on the following day there are 27 hours.

24 h. 40 sec. of the first clock $=$ 1 day of the correct clock,

i.e., $\frac{2161}{90}$ h. .... $=$ 1 day ....,

$\therefore$ 1 h. .... $= \frac{90}{2161}$ da. ....,

$\therefore$ 27 h. .... $= \frac{90 \times 27}{2161}$ da. ....,

Now $\frac{90 \times 27}{2161}$ da. $=$ 1 da. 2 h. $59\frac{541}{2161}$ min.

$\therefore$ When the first clock indicates 3 P. M. on the following day, the true time will be 2 h. $59\frac{541}{2161}$ min. P. M.

EXAMPLES. 130.

1. A watch which is 5 minutes too fast at 12 o'clock on Sunday gains 2 min. 15 sec. per day; what time will it indicate at half past 2 P. M. on the following Tuesday?

2. A clock which is 10 minutes too fast at 9 A. M. on Monday loses 3 min. per day; what time will it show at a quarter to 3 P. M. on the following Wednesday?

3. One clock gains 2 minutes, and a second gains 3 minutes in 24 hours: the first is put right at 12 o'clock on Tuesday, the second at 3 P. M. on the following Wednesday: when will they indicate the same time?

4. Two clocks are exactly together at 8 A. M. on a certain day; one loses 6 seconds and the other gains 10 seconds in 24 hours; when will the one be half an hour before the other, and what time will each clock then show?

5. A watch which shows correct time at noon on Tuesday gains $2\frac{1}{2}$ min. a day: what is the correct time on the following Sunday when it is 9 A. M. by the watch?

6. Two clocks strike 9 together on Monday morning; on Tuesday morning one wants 10 minutes to 11, when the other strikes 11. How much must the slower be put on, or the faster put back, that they may strike 9 together in the evening?

7. A clock which was $1\cdot\dot{4}$ min. fast at a quarter to 11 P. M. on Dec. 2, was 8 min. slow at 9 A. M. on Dec. 7; when was it exactly right?

8. A clock which was $1\cdot\dot{2}$ min. fast at a quarter to 11 P. M. on Nov. 28, was exactly right at 11·30 P. M. the following day. How many minutes was it slow at a quarter to 2 P. M. on Dec. 7?

9. A clock which is $7\frac{1}{2}$ min. fast on Tuesday at noon, is $4\frac{1}{4}$ min. fast at midnight on the following Monday; how much did it lose in a day?

10. A watch which gains $7\frac{1}{2}$ min. in a day is 12 minutes fast at midnight on Sunday. What will be the true time when the watch indicates 4·32 P. M. on Wednesday?

11. Two clocks, of which one gains $3\frac{1}{2}$ min. and the other loses $2\frac{1}{2}$ min. in 24 hours, were both within 1 min. of the true time, the former fast and the latter slow, at noon on Sunday last; they now differ from one another by 15 min.: find the day of the week and the hour of the day.

12. A clock loses $2\frac{1}{2}$ minutes a day; how must the hands be placed at 9 A. M. so as to point to true time at noon?

13. One clock gains $12\frac{1}{2}$ minutes, and another gains $7\frac{1}{2}$ minutes in 12 hours. They are set right at noon on Sunday. Determine the time indicated by each clock, when the one appears to have gained $21\frac{2}{3}$ min. on the other.

14. A clock set accurately at 1 o'clock indicates 10 minutes to 6 at 6 o'clock: what is the true time when the clock indicates 6 o'clock?

15. A watch is 73 seconds slow at noon on January 1st 1887: how much must it gain daily that it may be $17\frac{1}{2}$ seconds fast at noon on July 1st?

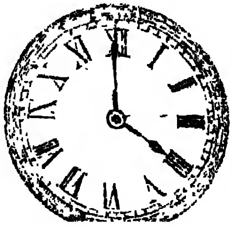
16. A watch is set right at 10 P. M. on Sunday; at 10 A. M. on Wednesday it is 5 minutes too fast; what will be the true time when it is 2 P. M. by the watch on Friday?

17. A watch which gains 5 minutes in 12 hours is put right on January 1st 1888; when will it again show correct time?

18. A church-clock was 15 minutes too fast 10 days ago, and to-day at the same hour it is 15 minutes too slow: when did it show true time? When will it again show true time?

19. Two clocks, of which one gains and the other loses one minute in an hour, strike one o'clock together; what will be the interval, measured by a correct clock, between their respective striking 2?

Example 2. Find the time between 4 and 5 o'clock when the hands of a clock are (i) together, (ii) at right angles, (iii) opposite to each other.



Note. While the minute-hand passes over 60 minute-divisions the hour-hand passes over only 5. Therefore in 60 minutes the minute-hand gains 55 divisions on the hour hand; and therefore in 12 minutes the minute-hand gains 11 divisions on the hour-hand.

At 4 o'clock the minute-hand is 20 divisions behind the other.

(i) The two hands to be together between 4 and 5, the minute-hand has to gain 20 divisions on the hour-hand.

The minute-hand gains 11 divisions in 12 minutes,

$\therefore$ .... 1 division in $\frac{12}{11}$ ....,

$\therefore$ .... 20 divisions in $\frac{12\times 20}{11}$ .... ;

$\therefore$ the time required is $\frac{12\times 20}{11}$ min. or $21\frac{9}{11}$ min. past 4.

(ii) When the hands are at right angles there is a space of 15 minute-divisions between them. Between 4 and 5 this will happen twice: first, when the minute-hand has gained 5 (*i. e.*, 20 − 15) divisions; and secondly, when it has gained 35 (*i.e.*, 20 + 15) divisions.

The minute-hand gains 11 divisions in 12 minutes,

$\therefore$ .... 1 division in $\frac{12}{11}$ ....,

$\therefore$ .... 5 divisions in $\frac{12\times 5}{11}$ .... ;

and .... 35 divisions in $\frac{12\times 35}{11}$ ....

$\therefore$ The two hands will be at right angles at $\frac{12\times 5}{11}$ min. or $5\frac{5}{11}$ min. past 4; and also at $\frac{12\times 35}{11}$ min. or $38\frac{2}{11}$ min. past 4.

(iii) When the hands are opposite to each other, there is a space of 30 divisions between them. This will happen when the minute-hand has gained 50 (*i.e.*, 20 + 30) divisions.

The process will be similar to that in the preceding cases. The time is $54\frac{6}{11}$ min. past 4.

EXAMPLES. 131.

At what time are the hands of a clock (i) coincident, (ii) at right angles, (iii) opposite each other, (iv) 12 divisions apart, (v) 22 divisions apart, between the hours of

1. 2 and 3? **2.** 3 and 4? **3.** 6 and 7?

4. 12 and 1? 5. 7 and 8? 6. 10 and 11?

7. A watch is 10 minutes too fast at noon; it loses 2 min. in one hour: find the true time when its hands are at right angles between 2 and 3 o'clock.

8. A clock is 5 minutes too slow at 1; it gains 1 min. in an hour: what is the true time when its hands are together for the fifth time after 1 o'clock?

9. A clock is put right at 4 P. M.; it gains $1\frac{1}{2}$ min. an hour; what is the true time when its hands are at right angles for the fourth time after 4?

10. A clock indicates correct time when its hands are together between 2 and 3 o'clock; if it had been losing 2 min. every hour, what time did it indicate at 12 noon?

11. A clock, in which the hour-hand has been displaced, shows the time to be 16 minutes past 3, and the two hands are together: the time is between 3 and 4 o'clock. Find by how many minute-divisions the hand has been displaced.

12. If the hands of a clock come together every 63 minutes (true time), how much does the clock gain or lose in a day?

PROBLEMS CONCERNING TIME AND DISTANCE.

207. *Example* 1. A passenger train leaves Calcutta at 4 P. M. and travels at the rate of 20 miles an hour; the mail train leaves Calcutta at 9 P. M. and travels, on a parallel line of rails, at the rate of 30 miles an hour: when and where will the second train overtake the first?

The first train has started 5 hours before the second; and is therefore (20×5) or 100 miles away when the second train starts. Therefore the second train has to gain 100 miles on the first; at the rate of 10 (*i.e.*, $30 - 20$) miles an hour.

Second train gains 10 miles in 1 hour on the first,

∴ .... 100 .... 10 hours................;

∴ the time required is 10 hours after the second train starts: and ∴ the second overtakes the first (30×10) or 300 miles from Calcutta.

Example 2. A hare, pursued by a greyhound, is 30 yards before him at starting; whilst the hare takes 4 leaps the dog takes 3; in one leap the hare goes $1\frac{1}{2}$ yards, and the dog, $2\frac{1}{2}$ yards: how far will the hare have gone when she is caught by the hound?

Whilst the hare runs $(4\times 1\frac{1}{2})$ yd., or 6 yd., the dog runs $(3\times 2\frac{1}{2})$ yd., or $7\frac{1}{2}$ yd. Hence

The dog gains $1\frac{1}{2}$ yd. whilst the hare runs 6 yd.,
∴ .... 3 yd. .... 12 yd.,
∴ .... 30 yd. .... 120 yd.;
∴ the required distance is 120 yd.

Example 3. A starts from P to walk to Q, a distance of $51\frac{3}{4}$ miles, at the rate of $3\frac{3}{4}$ miles an hour; an hour later B starts from Q for P and walks at the rate of $4\frac{1}{4}$ miles an hour; when and where will A meet B?

A has already gone $3\frac{3}{4}$ miles when B starts. Of the remaining 48 miles, A walks $3\frac{3}{4}$ and B walks $4\frac{1}{4}$ in one hour; that is, they together pass over $(3\frac{3}{4}+4\frac{1}{4})$ or 8 miles in one hour. Therefore 48 miles are passed over in $\frac{48}{8}$ or 6 hours. Therefore A meets B in 6 hours after B started. And therefore they meet at a distance of $4\frac{1}{4}\times 6$ or $25\frac{1}{2}$ miles from Q.

Example 4. Two trains, 77 yd. and 99 yd. long respectively, run at the rates of 25 and 20 miles an hour respectively on parallel rails in opposite directions: how long do they take to pass each other? How long would they take to pass each other if they were running in the same direction? How long would a person sitting in the first train take to pass the other?

(i) The two trains running in opposite directions will pass each other in the time in which $(77+99)$ or 176 yards are passed over at the rate of $(25+20)$ or 45 miles an hour.

Now, 45 miles are passed over in 1 hour,
i.e., 45×1760 yd. .... 1 hour,
∴ 176 yd. .... $\frac{1}{450}$ hour;
∴ the time required $=\frac{1}{450}$ hr., or 8 seconds.

(ii) When the trains run in the same direction they pass each other in the time in which $(77+99)$ or 176 yards are passed over at the rate of $(25-20)$ or 5 miles an hour. The time required will be found to be 72 seconds.

(iii) First, when the trains are running in opposite directions, a person sitting in the first train will pass the other in the time in which 99 yd. (*i.e.*, the length of the second train) are passed over at the rate of $(25+20)$ or 45 miles an hour. The required time will be found to be $4\frac{1}{2}$ seconds.

Secondly, when the trains run in the same direction, 99 yd. are to be passed over at the rate of $(25-20)$ or 5 miles an hour. The required time is $40\frac{1}{2}$ seconds.

Example 5. A man rows down a river 18 miles in 4 hours with the stream, and returns in 12 hours: find the rate at which he rows, and the rate at which the stream flows.

He rows 18 miles in 4 hours down the stream; therefore he rows $\frac{18}{4}$ or $4\frac{1}{2}$ miles an hour down the stream.

Again, he rows 18 miles in 12 hours up the stream; therefore he rows $\frac{18}{12}$ or $1\frac{1}{2}$ miles an hour up the stream.

$\therefore$ $4\frac{1}{2}$ miles an hour is the sum of the rate at which the man rows and the rate at which the stream flows; and $1\frac{1}{2}$ miles an hour is their difference. Hence the rates are 3 miles and $1\frac{1}{2}$ miles an hour respectively.

Example 6. If a snail, on the average, creep 31 inches up a pole during 12 hours in the night, and slip down 16 inches during the 12 hours in the day, how many hours will he be in getting to the top of a pole 35 feet high?

Length of the pole = 420 in. Now in 24 hours the snail creeps up $(31-16)$ in. or 15 in.; therefore in (24×26) hr. the snail creeps up (15×26) in., or 390 in.; therefore he has $(420-390)$ in., or 30 in. more to get up. And he goes over 31 in. in 12 hr., and therefore over 30 in. in $\frac{12\times 30}{31}$ hr. Therefore he reaches the top in $(24\times 26+\frac{12\times 30}{31})$ hr., or in $635\frac{19}{31}$ hours. [The number of days (26) has been so determined that $(420 \text{ in.} - 15 \text{ in.} \times 26)$ may be equal to 31 in. or just less than 31 in.]

EXAMPLES. 132.

1. One man takes 100 steps a minute, each 2 ft. long; another walks 4 miles an hour: if they start together, how soon will one of them be 38 yards ahead of the other?

2. A person wishing to go from *A* to *B* walked for $4\frac{1}{2}$ hours at the rate of 1 mile in $21\frac{1}{4}$ min., he then rode for $16\frac{1}{2}$ hours three times as fast as he walked, and then had to travel by rail for $10\frac{1}{2}$ hours three times as fast as he rode; find the distance from *A* to *B*.

3. A train leaves Calcutta at 7-30 A. M. and travels 25 miles an hour; another train leaves Calcutta at noon and travels 30 miles an hour: when and where will the second train overtake the first?

4. A train going 30 miles an hour leaves Calcutta for Allahabad (600 miles) at 9 P. M., another train going 40 miles an hour leaves Allahabad for Calcutta at the same time; when and where will they pass each other?

5. Two trains, each 88 yards long, are running in opposite directions on parallel rails, the first at 40 miles an hour, the

other at 35 miles an hour; how long will they take to pass each other?

6. In the above example, if the trains run in the same direction, how long will a person sitting in the faster train take to pass the other?

7. A man rows down a river 15 miles in 3 hou[illegible] stream and returns in $7\frac{1}{2}$ hours; find the rate at wh[illegible] and the rate at which the stream flows.

8. A man rows 12 miles in 5 hours against the [illegible]te of which is 4 miles an hour: how long will he b[illegible] miles with the stream?

9. A policeman goes after a thief who has [illegible]art; if the policeman run a mile in 6 minutes, and t[illegible] mile in 10 minutes, how far will the thief have gone be[illegible]rtaken?

10. A man starts at 7 A. M. and travels [illegible] of $4\frac{1}{2}$ miles an hour: at 8-15 A. M. a coach starts f[illegible]e place and follows the man, travelling at the rate [illegible] an hour: at what o'clock will the coach overtake th[illegible]

11. *A* starts from Allahabad [illegible] and walks at the rate of 5 miles an hour; *B* start[illegible]awnpore 3 hours later and walks towards Allahabad at the [illegible]iles an hour: if they meet in 11 hours after *B* started, [illegible]stance from Allahabad to Cawnpore.

12. *A* starts from Calcu[illegible] (24 miles) at 6 A. M. walking 4 miles an hour; *B* s[illegible]lcutta an hour later and reaches Hugli one hour before [illegible]id they meet?

13. A man walks to a town [illegible] of $3\frac{1}{2}$ miles an hour and rides back at the rate of 6 mile[illegible]: how far has he walked, the whole time occupied havin[illegible]urs 10 minutes?

14. *A* and *B* run a mile in [illegible]irections: while *A* runs 6 yards *B* runs 5; *B* gets 9 se[illegible], during which time he runs $22\frac{1}{2}$ yards; find when he [illegible]

15. A train leaves Calcutt[illegible] and reaches Burdwan at 11 A. M.; another train lea[illegible]an at 8 A. M. and reaches Calcutta at 10-30 A. M.; at wh[illegible] they meet?

16. A train starts from *P* [illegible]elling 20 miles an hour; $1\frac{1}{2}$ hours later another train [illegible] *P* and travelling at the rate of 30 miles an hour reache[illegible]urs before the first train: find the distance from *P* to *Q*[illegible]

17. A horseman leaves Ma[illegible] M. and in 5 hours overtakes a coach which left Madr[illegible] If the coach had been 2 miles farther on the road w[illegible]rseman started, it would

have been overtaken in 7 hours. Find the rates of the horseman and the coach.

18. *A* and *B* start at the same time from Patna and Bankipore, and proceed towards each other at the rates of 3 and 4 miles per hour respectively. They meet when *B* has walked one mile farther than *A*. Find the distance between Patna and Bankipore.

18a. *A*, *B* and *C* start from the same place at intervals of an hour and walk at the rate of 3, 4 and 5 miles an hour respectively. *A* starts first, but when he is overtaken by *B* he returns towards the starting-place; find the distance from the starting-place where he would meet *C*.

19. A man rides at the rate of 11 miles an hour, but stops 5 minutes to change horses at the end of every 7th mile; how long will he take to go a distance of 94 miles?

20. A man rides [redacted] of 10 miles an hour, but stops 10 minutes to change ho[redacted] end of every 12th mile; how long will he take to go a d[redacted]96 miles?

21. If a gun fir[redacted] every 9 minutes, how many will it fire in an hour?

22. A monkey, c[redacted] a greased pole, ascends 10 ft. and slips down 3 ft. in al[redacted]utes. If the pole is 63 ft. high, how long will it take [redacted]h the top?

23. A vessel has [redacted]ached to it, 1 to supply and 1 to draw off. The suppl[redacted]ill the vessel in 40 minutes, and the waste-pipe can e[redacted]an hour. If the supply-pipe and waste-pipe are kept o[redacted]ate minutes, in what time will the vessel be filled?

24. A boy and a [redacted]o fill a cistern: the boy brings a quart at the end of ev[redacted]s and the girl brings a pint every 3 minutes. In what [redacted]e cistern be filled, if it holds $4\frac{1}{2}$ gallons?

203. *Example.* [redacted] start from the same point and travel round an island [redacted] circumference, *A* and *B* travelling in the same direction [redacted] opposite direction. If *A* travels at the rate of 5, *B* [redacted] and *C* at the rate of 8 miles an hour, in how many [redacted]ll come together again?

$\because$ *B* gains 2 m[redacted] $\therefore$ he gains 30 miles or a complete circuit in [redacted]nd *B* are together at the end of every 15 hours. *A* an[redacted] pass over 13 miles in 1 hr.; $\therefore$ they come together [redacted]rs. And therefore *A*, *B* and *C* will come together at [redacted] number of hours which is a common multiple of 15 [redacted]ut the L. C. M. of 15 and $\frac{30}{13}$ is 30; therefore *A*, *B*, *C* [redacted]her at the end of 30 hours.

EXAMPLES. 133.

1. A and B start together from the same point to walk round a circular course, 10 miles long ; A walks 4 miles and B 3 miles an hour. When will they next meet, (i) if they walk in the same direction, (ii) if they walk in opposite directions ?

2. A takes 3 hours and B takes 5 to walk round a park. If they start together, when will they next meet, supposing (i) that they walk in the same direction, (ii) that they walk in opposite directions ?

3. A, B, C start from the same point and travel in the same direction round an island 63 miles in circumference: A at the rate of 10, B at the rate of 12, and C at the rate of 16 miles a day : in how many days will they come together again ?

4. A can go round an island in 15 days, B can go round it in 20 days and C in 25 days. If they start simultaneously from the same point, A and B travelling in one direction and C in the opposite direction, in how many days will they come together again ? In how many days will they come together again at the starting point ?

5. Three boys agree to start together from the same point and run round a circular park 6 miles in circumference ; they run at the rates of 3, 5 and 7 miles per hour respectively ; in how many hours will they come together again ? In what time will they come together again at the point from which they started ?

RACES AND GAMES OF SKILL.

204. *Example* 1. A can beat B by 40 yards in a mile race ; B can beat C by 20 yards in a mile race : if A and C run a mile, by how much will A win ?

$\because$ A can run 1760 yards while B runs 1720,

$\therefore$ A .... $\frac{1760}{43}$ .... B 40,

$\therefore$ A .... $\frac{1760 \times 44}{43}$ .... B 1760,

[But B .... 1760 .... C ...... 1740,]

$\therefore$ A .... $\frac{1760 \times 44}{43}$ .... C 1740,

$\therefore$ A .... 1760 .... C ...... $\frac{1740 \times 43}{44}$ or $1700\frac{5}{11}$ yd.

$\therefore$ A will win by $(1760 - 1700\frac{5}{11})$ or $59\frac{6}{11}$ yards.

Example 2. A can give B 20 yards, and C 30 yards in a race of 200 yards : how many yards can B give C in 300 yards ?

[**Note.**—"*A* can give *B* 20 yards in 200 yards" means that in a race of 200 yards *A* can give *B* 20 yards' start. Consequently while *A* runs 200 yards *B* runs 180 yards.]

While *A* runs 200 yards *B* runs 180,
and ...... *A* ...... 200 .... *C* 170,
∴ .... *B* ...... 180 .... *C* 170,
∴ .... *B* ...... 60 .... *C* ...... $\frac{170}{3}$,
∴ .... *B* ...... 300 .... *C* ...... $\frac{170 \times 5}{3}$ or $283\frac{1}{3}$ yards.
∴ *B* can give *C* $(300 - 283\frac{1}{3})$ or $16\frac{2}{3}$ yards in 300.

Example 3. In a game of skill *A* can give *B*, and *B* can give *C*, 10 points out of a game of 50; how many should *A* give *C*?

[**Note.**—"*A* can give *B* 10 points out of a game of 50" means that while *A* makes 50 points *B* can make $(50 - 10)$ or 40 points.]

C can make 40 points while *B* makes 50,
∴ *C* .... 4 .... *B* 5,
∴ *C* .... 32 .... *B* 40;
But *A* .... 50 .... *B* 40;
∴ *C* .... 32 .... *A* .... 50.
∴ *A* can give *C* $(50 - 32)$ or 18 points in 50.

EXAMPLES. 134.

1. In a mile race *A* gives *B* 60 yards' start, and beats him by 28 yards. If *A* runs the mile in 5 minutes, how long will *B* take?

2. In a mile race *A* can beat *B* by 40 yards, and *B* can beat *C* by 40 yards: how many yards' start can *A* give *C* that there may be a dead heat?

3. *A* can give *B* 60 yards, and *C* 80 yards in a race of 500 yards: by how much could *B* beat *C* in a mile race?

4. *A* runs 15 yards while *B* runs 12; *B* runs 10 miles while *C* runs 12: if *C* runs a mile in 10 minutes, what time will *A* take to do it?

5. At a game of skill *A* can give *B* 15 points out of 50, and *A* can give *C* 10 points out of 40: which is the better player, *B* or *C*, and how many points can he give the other in 75?

6.* *A* and *B* run a mile race; *A* runs the whole course at the rate of 100 yards per minute; *B* running at the rate of 80 yards per minute for 5 minutes, quickens his speed to 120 yards per minute: which wins? by how much? and by what time?

7. In a game of billiards A can give B 10 points, and C 14 points in 50: how many can B give C so as to make an even match?

8. A can give B 300 yards in 1 mile, and C can give B 700 yards in 2 miles; if A and C run a mile, which will win and by how much?

9. A can give B 100 yards' and C 150 yards' start in a mile; B can give C a start of 5 seconds in a mile: how long does each take to run half a mile?

10. In a mile race A gives B 50 yards' start, and beats him by 38 yards; B giving C 40 yards' start is beaten by 60 yards: if A and C run over the same course, which will win and by how much?

11. At a game of rackets A can give B 8 points in 40, and B can give C 10 points in 50: how many points could A give C in 25?

12. A can give B 20 yards' and C 30 yards' start, while B can give C 2 seconds' start in a race of 250 yards; how long does each take to run 100 yards?

13. One boy runs 200 yards and another 180 yards in a minute. How many yards' start must the second have that they may run a dead heat in a mile race?

14. In a game at fives A can give B 3 points out of 15, and A can give C 7 points: how many points can B give C so as to make an even match?

15. A and B run a mile and A wins by half a minute. A and C run a mile and A beats C by 88 yards. B and C run and B wins by 20 seconds. In what time can each run a mile?

16. A beats B by 20 yards, C beats D by 60 yards, and B beats D by 40 yards, in a mile race. If A and C run, which will win and by how much?

CHAIN RULE.

205. *Example* 1. If 8 rupees are worth 15 shillings, and 25 shillings are worth 6 dollars, how many dollars are equal to 45 rupees?

$$\text{R}8 = 15s., \qquad \therefore \text{R}1 = \tfrac{15}{8}s.$$
$$25s. = 6 \text{ dollars}, \qquad \therefore 1s. = \tfrac{6}{25} \text{ dollars}.$$
$$\therefore \text{R}45 = 45 \times \tfrac{15}{8}s.$$
$$= 45 \times \tfrac{15}{8} \times \tfrac{6}{25} \text{ dollars, or } 20\tfrac{1}{4} \text{ dollars.}$$

Example 2. If A in 3 days can do as much work as B in 4 days, and B in 5 days can do as much as C in 6 days, how long will A require to do a piece of work which C can do in 16 days?

What C can do in 6 da. B can do in 5 da,

$\therefore$ .... C .... 1 .... B .... $\frac{5}{6}$ ....,

and .... B .... 4 .... A .... 3 ...,

$\therefore$ .... B .... 1 .... A .... $\frac{3}{4}$ ....;

$\therefore$ What C can do in 16 days B can do in $16\times\frac{5}{6}$ days,

$\therefore$ .... C .... A .... $16\times\frac{5}{6}\times\frac{3}{4}$ days

or 10 days.

EXAMPLES. 135.

1. If 25 rupees are worth 46 shillings, 20 shillings are worth 25 francs, and 240 francs are worth 47 dollars, how many dollars are equivalent to 40 rupees?

2. If R8 = 15*s*., £3 = 20 thalers, and 25 thalers = 93 francs, express a franc in Indian money.

3. If 72 carlini = 25 shillings, 4 shillings = 5 francs, and 8 scudi = 45 francs, how many scudi are equal to 1296 carlini?

4. If 5 chickens cost as much as 4 ducks, 6 ducks cost as much as 3 geese, and 7 geese cost as much as 5 turkeys, what is the price of a chicken when a turkey costs R8?

5. If 5 lb. of tea be worth 3 lb of coffee, 5 lb of coffee be worth 2 lb. of sugar, and 7 lb. of sugar be worth 30 lb. of rice, how many pounds of tea must be given in exchange for 20 lb. of rice?

6. If 12 oxen eat as much as 29 sheep, 15 sheep eat as much as 25 hogs, 17 hogs eat as much as 3 camels, and 8 camels eat as much as 13 horses, how many horses will eat as much as 1632 oxen?

7. If A can do as much work in 4 days as B can do in 5, and B can do as much in 6 days as C in 7; in what time will C do a piece of work which A can do in a week?

8. If A can do as much work in $1\frac{1}{2}$ days as B can do in 2, and B can do as much in $2\frac{1}{2}$ days as C in 3; in what time will A and B together do a piece of work which C can do in 10 days?

9. While A does $\frac{1}{3}$ of a piece of work B does $\frac{1}{4}$, and while B does $\frac{1}{5}$ C does $\frac{1}{6}$; in how many hours will C finish a piece of work which A finishes in 20 hours?

10. If 3 ducks are worth 4 chickens, and 3 geese are worth 10 ducks, find the value of a goose, a pair of chickens being worth 4*a*. 6*p*.

XXXVI. COMPLEX PROBLEMS.

206. In the problems in the preceding section we have found the change in one quantity corresponding to the change in *one* other. In the following examples we shall have to find the change in one quantity corresponding to the changes in *two* others.

Example 1. If 15 horses can plough 12 acres in 10 days, in how many days can 9 horses plough 18 acres?

15 horses can plough 12 acres in 10 days,

$\therefore$ 1 horse .... 12 acres in (10×15) days.

$\therefore$ 1 horse .... 1 acre in $\frac{10 \times 15}{12}$ days,

$\therefore$ 9 horses .... 1 acre in $\frac{10 \times 15}{12 \times 9}$ days,

$\therefore$ 9 horses .... 18 acres in $\frac{10 \times 15 \times 18}{12 \times 9}$ days,

or 25 days. *Ans.*

Note. We might use 3 horses and 6 acres as common units with advantage. Thus:

15 horses can plough 12 acres in 10 days,

$\therefore$ 3 horses .... 12 acres in 10×5 days,

$\therefore$ 3 horses .... 6 acres in $\frac{10 \times 5}{2}$ days,

$\therefore$ 9 horses .... 6 acres in $\frac{10 \times 5}{2 \times 3}$ days,

$\therefore$ 9 horses .... 18 acres in $\frac{10 \times 5 \times 3}{2 \times 3}$ days,

or 25 days. *Ans.*

Example 2. If 6 men earn R15 in 10 days, how much do 8 men earn in 7 days?

In 10 days 6 men earn R15,

$\therefore$ in 1 day 6 men earn R$\frac{15}{10}$ or R$\frac{3}{2}$,

$\therefore$ in 1 day 1 man earns R$\frac{3}{6 \times 2}$ or R$\frac{1}{4}$,

$\therefore$ in 7 days 1 man earns R$\frac{7}{4}$,

$\therefore$ in 7 days 8 men earn R$\frac{7 \times 8}{4}$ or R14. *Ans.*

Example 3. If 6 men can do a piece of work in 8 days, how many men can do a piece of work 4 times as great in $\frac{1}{3}$ of the time?

The work can be done in 8 days by 6 men,

$\therefore$ .... $\frac{8}{3}$ .... 18 men,

$\therefore$ 4 times the work .... $\frac{8}{3}$ .... 72 men. *Ans.*

Example 4. If the sixpenny loaf weigh 8 oz. when wheat is 15*s.* a bushel, what ought a bushel of wheat to be when the fourpenny loaf weighs 12 oz.?

	Sixpenny	loaf weighs	8 oz. when wheat is	15*s*. a bushel,
∴	penny	loaf weighs	8 oz.	$\frac{5}{2}$*s*. ....,
∴	penny	loaf weighs	1 oz.	20*s*. ....,
∴	fourpenny	loaf weighs	1 oz.	80*s*. ....,
∴	fourpenny	loaf weighs	12 oz	$\frac{20}{3}$*s*. ....,

or 6*s*. 8*d*. a bushel.

Example 5. If 5 cannon, which fire 3 rounds in 5 minutes, kill 135 men in 1½ hours, how many cannon, which fire 5 rounds in 6 minutes, will kill 250 men in 1 hour?

	In 54 rounds	135 men are killed by	5	cannon,
∴	... 1 round	135	5×54	..........,
∴	... 1 round	1 man is	$\frac{5 \times 54}{135}$	..........,
∴	... 50 rounds	1	$\frac{5 \times 54}{135 \times 50}$	..........,
∴	... 50 rounds	250 men are	$\frac{5 \times 54 \times 250}{135 \times 50}$	..........,

or 10 cannon.

EXAMPLES. 136.

1. If 5 men earn £3 in 12 days, in how many days will 8 men earn £4?

2. If 10 horses can plough 50 acres in 20 days, how many acres will 12 horses plough in 15 days?

3. If 24 horses eat 9 bushels of corn in 21 days, for how many days will 33 bushels feed 7 horses?

4. If 30 men can build a wall 20 ft. high in 15 days, how many men will it take to build one 25 ft. high in 7½ days?

5. If 12 horses are fed for 17 days at a cost of R110. 8*a*., how many horses can be fed for 27 days at a cost of R117?

6. If 10 fires consume 75 maunds of coal in 14 days, in how many days will 18 fires consume 100 maunds?

7. If the carriage of 10 md. 20 seers for 250 miles be R41. 0*a*. 3*p*., what should be paid for the carriage of 12 md. for 200 miles?

8. If the wages of 13 men for 25 days amount to R20. 5*a*., how many men must work for 16 days to receive R30?

9. What is a month's rent for 116⅔ bighas of land, if R22. 8*a*. per annum be given for 9 bighas?

10. If 14 persons can live on R1400 for 28 months, how long can 18 persons live on R1350?

11. If 5 men dig a trench 7½ yd. long in 21 days, how many men can dig a similar trench 20 yd. long in 35 days?

12. If 20 pumps can raise 1250 maunds of water in 5 hours, how many pumps can raise 750 maunds of water in 10 hours?

13. If 20 men do a piece of work in 13 days, in what time can 15 men do another piece of work $2\frac{1}{2}$ times as great?

14. If 10 men do a piece of work in 8 days, how many men will do a piece of work, 4 times as great, in $\frac{1}{4}$ of the time?

15. If the fourpenny loaf weighs 10 oz. when wheat is 50*s.* a quarter, what should a threepenny loaf weigh when wheat is 55*s.* a quarter?

16. If 3 lb loaf cost 8*d.* when corn is 30*s* per bushel, how much ought the 5 lb. loaf to cost when corn is 36*s.* per bushel?

17. If I get 1 lb. weight of bread for $7\frac{1}{2}$*d.* when wheat is 15*s.* a bushel, what ought a bushel of wheat to be when I get 12 oz. of bread for 4*d.*?

18. If 14 men in 20 days of $12\frac{1}{2}$ hours each earn R456. 4*a.*, how many hours a day should 24 men work to earn R547. 8*a.* in 21 days, at the same rate?

19. If 15 men can do a piece of work in 12 days of 6 hours each, how many men will it take to do 5 times the amount if they work 20 days of 10 hours each?

20. If a man complete a journey of 1980 miles in 18 days, travelling 11 hours a day, in how many days would he travel 540 miles, going 6 hours a day at the same rate?

21. When rice is R2. 8*a.* a maund, 10 men can be fed for 12 days at a certain cost: how many men can be fed for 4 days at the same cost, when rice is R3 a maund?

22. When flour is R4 a maund, 16 men can be fed for 5 days at a cost of R8; for how many days can 12 men be fed at a cost of R10 8*a.*, when flour is R3. 8*a.* per maund?

23. If 15 men can build a wall 270 ft. long, 5 high and 2 thick, in 18 days, in how many days will 16 men build a wall 180 ft. long, 4 high and 3 thick?

24. If 10 men working 6 hours a day dig a trench 105 ft. long, 4 wide and 2 deep in 6 days, how many hours a day must 264 men work in order to dig a trench 126 ft. long, 20 wide and 11 deep in 10 days?

25. A garrison of 1200 men is provisioned for 50 days, allowing 10 oz. per man per day; if it is re-inforced by 300 men, to what must the daily allowance be reduced that the provisions may last the increased number of men 60 days?

26. If the carriage of goods weighing 2 cwt. 3 qr. 6 lb. for 300 miles cost £6 . 10 . 10, what will be the charge for carrying

2 wagon-loads of the same, each weighing 14 cwt. 0 qr. 4 lb., 450 miles ?

27. If the gas for 6 burners, 6 hours every day, for 8 days, cost R4. 8*a.*, how many burners may be lighted 5 hours every evening for 10 days at the cost of R6. 4*a.* ?

28. If 3 cannon, firing 4 rounds in 6 minutes, kill 250 men in half an hour, how many cannon, firing 3 rounds in 5 minutes, will kill 600 men in an hour ?

29. If 15 men can make an embankment, 966 yd. long, in 8 days, working $10\frac{1}{2}$ hours daily, how many men would be required to make an embankment, 575 yd. long, in 12 days, working $7\frac{1}{2}$ hours daily, 8 extra men being taken on during the last 2 days ?

30. If 50 men, working 8 hours a day, dig in 5 days, a trench of 275 cu. yd. ; in how many days of 10 hours each could 40 men dig a trench of 330 cu. yd., when the hardness of the ground in the first case is twice that in the second, and 3 men of the former company can do the work of 4 men of the latter ?

31. If 6 men, working 8 hours a day, can mow 60 acres in 4 days ; in how many days will 4 men, two of whom work 10 hours and two 7 hours a day, mow 85 acres ?

32. If 6 men and 8 boys can reap a field of 15 acres in 4 days, how many acres will 7 men and 4 boys reap in 9 days, two boys reaping as much as a man in the same time ?

33. If 4 horses eat as much as 18 sheep, and if 5 horses and 30 sheep can be kept for 15 days at a cost of R51 . 3 . 6, at what cost can 7 horses and 15 sheep be kept for 20 days ?

34. The rent of a farm of $41\frac{1}{4}$ acres for 39 months was R89. 6*a.* ; what would be the area of another farm, the rent of which for 33 months was R103. 2*a.*, 4 acres of the latter being worth as much as 3 acres of the former ?

35. A vessel with a crew of 27 men, provisioned for 90 days at the rate of 22 oz. a day per man, was, after 27 days, forced by stress of weather to lie at anchor for a fortnight, at the end of which time 3 men died ; how must the provisions be apportioned that they may hold out the extra time ?

36. If 10 men or 16 boys, working 6 hours a day, can do a piece of work in 20 days, how many hours a day must 7 men and 8 boys work to do another piece of work 3 times as great in 15 days ?

37. If 5 men, 8 women or 12 boys can do a piece of work in 16 days, working 7 hours a day, how many men, with the assistance of 4 women and 6 boys, will be able to do another piece of work $2\frac{1}{4}$ times as great in 35 days, working 5 hours a day ?

207. The following problems are of a different class.

Example 1. The price of 5 horses and 6 oxen is R680, that of 4 horses and 7 oxen is R610; find the price of an ox.

The price of 5 horses and 6 oxen = R680,

∴ .... 20 .... 24 .... = R2720. ....(i)

Again .... 4 .... 7 .... = R610,

∴ .... 20 .... 35 .... = R3050 ;.........(ii)

∴ the price of 11 oxen = R3050 − R2720 [subtracting (i) from (ii)]

= R330 ;

∴ the price of 1 ox = R30.

Example 2. 3 men and 5 boys can do $\frac{19}{20}$ of a piece of work in 3 days; 4 men and 8 boys can do $\frac{14}{15}$ of it in 2 days: in what time can a boy do the whole work?

In 3 days 3 men and 5 boys can do $\frac{19}{20}$,

∴ ... 1 day 3 .... 5 .... $\frac{19}{60}$,

∴ ... 1 day 12 .... 20 .... $\frac{19}{15}$ ....(i)

Again ... 2 days 4 .... 8 .... $\frac{14}{15}$,

∴ ... 1 day 4 .... 8 .... $\frac{7}{15}$,

∴ ... 1 day 12 .... 24 .... $\frac{7}{5}$; ....(ii)

∴ in 1 day 4 boys can do $(\frac{7}{5} - \frac{19}{15})$ of the work,

[subtracting (i) from (ii)]

i.e., ... 4 boys can do $\frac{2}{15}$ of the work,

∴ .... 1 boy can do $\frac{1}{30}$ of the work,

∴ 1 boy can do the whole work in 30 days.

EXAMPLES. 137.

1. If 9 horses and 7 cows cost R770, and 5 horses and 9 cows cost R530; find the price of a cow.

2. The price of 5 maunds of flour and 6 maunds of rice is R39. and that of 7 maunds of flour and 4 maunds of rice is R37; find the price of one maund of flour and of one maund of rice.

3. If 10 rupees and 11 shillings weigh 2760 grains, and 8 rupees and 10 shillings weigh $2312\frac{8}{11}$ grains, find the weight of a rupee and of a shilling.

4. If 7 sheep and 9 pigs cost R107, and 9 sheep and 7 pigs cost R101, how much will 1 sheep and 1 pig cost?

5. The cost of 4 chairs and 5 tables is R120, and that of 5 chairs and 4 tables R105; find the price of a chair and of a table.

6. 2 men and 3 boys can do $\frac{3}{4}$ of a piece of work in 6 days; 3 men and 5 boys can do $\frac{13}{24}$ of it in 4 days. In what time can a boy do the whole work?

7. 7 men and 8 boys can do a piece of work in 2 days; 4 men and 12 boys can do $\frac{29}{56}$ of the work in 1 day. In what time can a man do the work?

8. 5 men and 6 boys can do $\frac{2}{3}$ of a piece of work in 3 days; 10 men and 18 boys can do the whole work in 2 days. In what time will a man and a boy be able to do double the work?

9. If 6 men and 2 boys can reap 13 acres in 2 days, and 7 men and 5 boys can reap 33 acres in 4 days, how long will it take 2 men and 2 boys to reap 10 acres?

10. If 2 boys and 1 man can do a piece of work in 4 hours, and 2 men and 1 boy can do the same in 3 hours, find in what times a man, a boy, and a man and a boy together, respectively, could do the same.

11. On a piece of work 4 men and 5 boys are employed, who do $\frac{1}{3}$ of it in 6 days; after this, 1 man and 2 boys more are put on, and $\frac{1}{4}$ more is done in 3 days; how many more men must be put on to finish the work in one more day?

12. A cistern containing 210 buckets may be filled by two pipes. When the first pipe has been open 4 and the second 5 hours, 90 buckets of water were obtained. When the 1st was open 7 and the 2nd $3\frac{1}{2}$ hours, 126 buckets were obtained. In what time will the cistern be full, if both pipes work?

XXXVII. RATIO AND PROPORTION.

208. The **ratio** of one quantity to another of the same kind is that which expresses the relative greatness of the first quantity with respect to the second.

Hence, the ratio of one quantity to another (of the same kind) is determined by the *fraction* whose numerator is the measure of the first quantity and whose denominator is the measure of the second quantity, both the quantities being expressed in terms of the same unit.

Thus, the ratio of 3*s.* to 5*s.* is determined by the fraction $\frac{3}{5}$; of 2 yd. to 5 ft. by the fraction $\frac{6}{5}$.

The first of the two quantities forming a ratio is called the **antecedent** and the second is called the **consequent** of the ratio; the two together are called the **terms** of the ratio. The ratio of 3*s.* to 5*s.* is written 3*s.* : 5*s.*

Note. The *inverse* ratio of 3*s.* to 5*s.* is the ratio of 5*s.* to 3*s.*

209. The value of a ratio does not depend upon the nature of the quantities involved. Thus, the ratios, 2 yd. : 5 yd., 2*s.* : 5*s.*, 2 lb. : 5 lb., are all equal, each of these being determined by the fraction $\frac{2}{5}$. Hence, in investigating the properties of ratios, we usually consider the terms to be numbers, because numbers measure quantities of all kinds.

210. The value of a ratio is not altered by multiplying or dividing both its terms by the same number. Thus, the ratios, 2 : 3, 4 : 6, 80 : 120, are all equal.

211. Ratios are **compounded** by taking the product of the antecedents for a new antecedent and the product of the consequents for a new consequent. Thus the ratio compounded of the ratios, 2 : 3 and 6 : 7 is $2\times6 : 3\times7$ or 4 : 7.

212. Four quantities are said to be **in proportion** or **proportionals** when the ratio of the first to the second is equal to the ratio of the third to the fourth.

Thus 3, 4, 9, 12 are in proportion; since the ratio of 3 to 4 is equal to the ratio of 9 to 12.

N. B. When four quantities are in proportion, it is not necessary that all of them should be of the same kind; it is only necessary that the first two should be of the same kind, as also the second two.

The existence of proportion among the numbers is denoted thus :—

$$3 : 4 = 9 : 12,$$

which is read "3 to 4 equals 9 to 12";

or thus :— $3 : 4 :: 9 : 12,$

which is read "3 is to 4 as 9 is to 12."

Of this proportion 3 and 12 are called the **extremes**, and 4 and 9, the **means**; 12 is called **a fourth proportional** to 3, 4 and 9.

213. When four quantities are in proportion so that

first : second :: third : fourth ;

then also, second : first :: fourth : third ;

and fourth : third :: second : first.

Also, if the quantities are all of the same kind,

first : third :: second : fourth.

214. When four numbers are in proportion, the product of the extremes is equal to the product of the means.

For example, $3 : 4 = 6 : 8$, and we have $3 \times 8 = 4 \times 6$.

Hence also, an extreme = product of the means ÷ the other extreme ; and, a mean = product of the extremes ÷ the other mean.

215. Three quantities of the same kind are said to be **in continued proportion** when the ratio of the first to the second is equal to the ratio of the second to the third. The second quantity is called **a mean proportional** between the first and third ; and the third quantity is called **a third proportional** to the first and second.

Thus, 2, 4 and 8 are in continued proportion ; for $2 : 4 = 4 : 8$; 4 is a mean proportional between 2 and 8 ; and 8 is a third proportional to 2 and 4.

It is obvious that the square of the mean proportional between two numbers is equal to their product.

216. *Example* 1. Find a fourth proportional to 3, 9 and 4.

$$3 : 9 = 4 : \text{number required},$$
$$\therefore \text{ number required} = \frac{9 \times 4}{3} = 12.$$

Example 2. Find the number which has the same ratio to 20 that 3 has to 5.

$$3 : 5 = \text{number required} : 20,$$
$$\therefore \text{ number required} = \frac{3 \times 20}{5} = 12.$$

Example 3. Find a mean proportional between 3 and 12.

$$\text{Square of the number required} = 3 \times 12 = 36 ;$$
$$\therefore \text{ the number required} = \sqrt{36} = 6.$$

Example 4. A, B, C, D are quantities of the same kind ; and the ratio of A to B is $3 : 4$, of B to C is $5 : 7$, and of C to D is $8 : 9$. Find the ratio of A to D.

Now, $$\frac{A}{B} = \frac{3}{4},\ \frac{B}{C} = \frac{5}{7} \text{ and } \frac{C}{D} = \frac{8}{9} ;$$

$$\frac{A}{B} \times \frac{B}{C} \times \frac{C}{D} = \frac{3}{4} \times \frac{5}{7} \times \frac{8}{9}, \text{ or } \frac{A}{D} = \frac{10}{21} ;$$

that is, $$A : D :: 10 : 21.$$

Note. We find the **continued ratio** of A, B, C and D, that is, we compare A, B, C and D, thus :

$$\begin{aligned} A : B &= 3 : 4, \\ B : C = 5 : 7 = 1 : \tfrac{7}{5} &= 4 : \tfrac{28}{5}, \\ C : D = 8 : 9 = 1 : \tfrac{9}{8} = \tfrac{28}{5} &: \tfrac{63}{10}, \end{aligned}$$

We change the terms of the ratios in such a way that each antecedent may be equal to the preceding consequent.

$$\therefore\ A : B : C : D = 3 : 4 : \tfrac{28}{5} : \tfrac{63}{10}$$
$$= 30 : 40 : 56 : 63 ;$$

which is read "A is to B is to C is to D as 30 is to 40 is to 56 is to 63."

And A, B, C, D are said to be **in proportion of** or **proportional to** 30, 40, 56, 63.

Example 5. A mixture (42 gallons) contains wine and water in the ratio of 5 to 2 : find the quantities of wine and water in the mixture.

If the mixture be divided into 7 (*i.e.*, $5+2$) equal parts, 5 of the parts will be wine and 2 water

$\therefore$ The quantity of wine $= \frac{42}{7} \times 5$ gallons $= 30$ gallons ;

and the quantity of water $= \frac{42}{7} \times 2$ gallons $= 12$ gallons.

Example 6. A mixture (40 gallons) contains wine and water in the ratio of 3 to 1 ; how much water must be added to it that the ratio of wine to water may be $5 : 2$?

We find, as in the preceding example, that the mixture contains 30 gall. wine and 10 gall. water. Now while the wine remains the same 30 gallons, the water is to be increased so that the ratio of wine to water may be $5 : 2$; but $5 : 2 = 30 : 12$; $\therefore$ $(12 - 10)$ gall. or 2 gall. of water must be added.

EXAMPLES. 138.

Find the value of each of the following ratios in its simplest form :

1. $15 : 21$. **2.** R39 : R65. **3.** £3 : £5. 10*s*.

4. 360 in. : 270 in. **5.** 350 lb. : 725 lb. **6.** 2°. 5′ : 3°.

7. $3\frac{3}{4} : 5\frac{5}{8}$. **8.** $2\frac{8}{9} : 4\cdot\dot{3}$. **9.** 3 yd. : 7 ft. 6 in.

Express in its simplest form the ratio compounded of the ratios,

10. $7 : 9$ and $45 : 28$. **11.** $1 : 2$, $2 : 3$ and $3 : 4$.

12. $2\frac{1}{2} : 3\frac{1}{3}$ and $\cdot\dot{3} : \cdot 25$. **13.** $4 : 7$, $5 : 8$ and $21 : 30$.

Compare the ratios,

14. $3 : 5$ and $7 : 8$. **15.** $13 : 21$ and $18 : 29$.

16. $2 : 3$, $3 : 4$ and $4 : 5$. **17.** $3 : 7$, $5 : 9$ and $7 : 11$.

Are the following in proportion ?

18. 6, 11, 18, 33. **19.** 5, 7, 20, 27. **20.** R3, R2. 4*a*., 4, 3.

Find a fourth proportional to

21. 7, 9 and 8 **22.** $2\frac{1}{2}$, 3 and $4\frac{1}{3}$. **23.** ·2, ·02 and ·002.

24. R380, R570 and 12 lb. **25.** 4 yd., 2 yd. 2 ft. and £2.

26. 12 acres, 27 ac. and 20 men. **27.** 12 men, 9 men and £3.

28. 6 miles, 20 mi. and 9 hours. **29.** 3 cwt., 84 lb. and £1. 8*s*.

Find a mean proportional between

30. 7 and 28. **31.** 13 and 117. **32.** 9464 and 5600.

33. $\frac{16}{28}$ and $\frac{28}{63}$. **34.** $2\frac{1}{2}$ and $5\frac{5}{8}$. **35.** ·3 and ·012.

Find a third proportional to

36. $2\frac{1}{4}$ and $7\frac{1}{2}$. **37.** 7 and $5\frac{3}{5}$. **38.** R2 and R1. 4*a*.

39. Compare the rates of two trains, one of which runs 17 miles in 2 hours and the other $12\frac{1}{2}$ miles in $2\frac{1}{2}$ hours.

40. $A : B = 3 : 4$, $B : C = \frac{2}{3} : \frac{4}{3}$; find the ratio of A to C.

41. If $A = \frac{4}{5}$ of B, and $B = 2\frac{1}{3}$ of C, find the ratio of A to C.

42. If, when A earns R4, B earns R5 ; and when B earns R6, C earns R7 ; and when C earns R8, D earns R9 ; compare the earnings of A, B, C and D.

43. Two sums of money are proportional to 7 and 8 ; the first is £2 ; what is the other ?

44. The weights of equal volumes of gold and water are as 37 is to 2. If a cu. ft. of water weigh 1000 oz., find the weight of a cu. ft. of gold.

45. The ratio of the circumference of a circle to its diameter is 22 : 7 ; find the circumference of a circle 10 ft. 6 in. in diameter.

46. One man adds 5 seers of water to 15 seers of milk, and another 3 seers of water to 12 seers of milk ; compare the amount of milk in the two mixtures.

47. While A makes a profit of £3, B makes £4 ; and while B makes a profit of £5, C makes £6 ; if A makes a profit of £20, how much does C make in the same time ?

48. A mixture (50 gall.) contains wine and water in the ratio of 3 : 2 ; find the quantities of wine and water in the mixture.

49. A mixture (30 gall.) contains wine and water in the ratio of 7 to 3 ; how much water must be added to it that the ratio of wine to water may be 3 : 7 ?

50. A greyhound pursues a hare and takes 4 leaps for every 5 leaps of the hare, but 3 leaps of the hound are equal to 4 of the hare ; compare the rates of hound and hare.

XXXVIII. RULE OF THREE.

217. Problems which we have solved by the Unitary Method may also be solved by the method of finding a fourth proportional to three given quantities.

Example 1. Find the price of 12 maunds of sugar, when the price of 5 maunds is R60.

Here we observe that if the weight be *increased* 2, 3... times, the price will also be *increased* 2, 3... times; therefore the ratio of the two weights is equal to the ratio of the two corresponding prices.

Hence 5 md. : 12 md. :: R60 : the answer;

$\therefore$ the answer $=$ R$\frac{12 \times 60}{5}$ $=$ R144.

Example 2. If 12 men can do a piece of work in 5 days, in how many days will 15 men do it?

Here we observe that if the number of men be *increased* 2, 3... times, the number of days will be *decreased* 2, 3... times; therefore the *inverse ratio* of the numbers of men is equal to the *ratio* of the corresponding numbers of days.

Hence 15 men : 12 men :: 5 days : the answer;

$\therefore$ the answer $= \frac{12 \times 5}{15}$ days $=$ 4 days.

218. The above method of solving a problem by finding a fourth proportional to three given quantities is commonly known by the name of **Rule of Three.**

In the first problem we have an example of what is called the Rule of Three **Direct,** because there the *direct* ratio of the two weights is equal to the ratio of the corresponding prices.

In the second problem we have an example of what is called the Rule of Three **Inverse,** because there the *inverse* ratio of the numbers of men is equal to the ratio of the corresponding numbers of days.

219. It is obvious that the second term in a proportion is greater or less than the first according as the fourth is greater or less than the third. Hence we may lay down the following general rule for arranging the terms in a Rule of Three question.

Denote the answer by the letter x and place it for the 4th term; and of the three given quantities place that which is of the same kind as the answer, for the 3rd term. Next from the nature of the question determine whether the answer will be greater or less than the 3rd term, and place the greater or less of the two remaining quantities for the 2nd term according as the answer is greater or less than the 3rd term; then place the remaining quantity for the first term.

Note. In working, the two first quantities in the proportion must be replaced by the numbers which measure them in terms of the same unit.

Example 1. If the third class railway fare for 110 miles is R1 . 11 . 6, what is the fare for 350 miles?

$$\begin{array}{l} \text{mi.} \quad \text{mi.} \quad \text{R.} \; a. \; p. \\ 110 : 350 :: 1 . 11 . 6 : x, \end{array}$$

i.e., $11 : 35 :: 1 . 11 . 6 : x$;

$$\therefore \; x = \frac{\text{R}1 . 11 . 6 \times 35}{11} = \frac{\text{R}60 . 2 . 6}{11}$$

$$= \text{R}5 . 7 . 6. \quad \textit{Ans.}$$

Or thus : $\because$ R1 . 11 . 6 = 330*p*.

$$x = \tfrac{35 \times 330}{11} p. = 1050 p.$$

$$= \text{R}5 . 7 . 6.$$

The latter method is the one more generally adopted. The learner should observe that the 3rd term being expressed in pies the answer obtained at the first instance is also in pies.

Example 2. If a quantity of rice serve 100 men for 15 weeks, how many men will it serve 6 weeks?

weeks		weeks		men		
6	:	15	::	100	:	x
2	:	5	::	100	:	x

$\therefore \; x = \frac{5 \times 100}{2}$ men = 250 men. *Ans.*

Example 3. A bankrupt's debts amount to £1320, and his assets (*i.e.*, the value of his property) are £990, how much can he pay in the pound?

$$\begin{array}{l} \pounds. \quad \pounds. \quad \pounds. \\ 1320 : 1 :: 990 : x, \end{array}$$

$$\therefore \; x = \pounds\tfrac{1 \times 990}{1320} = \pounds\tfrac{3}{4} = 15s. \quad \textit{Ans.}$$

Example 4. A man, after paying an income-tax of 4*p*. in the rupee, has R4794 left; what is his gross income?

$$\text{R}1 = 192p. \; ; \; \text{R}1 - 4p. = 188p.$$

$$\begin{array}{l} p. \quad p. \quad \text{R.} \\ 188 : 192 :: 4794 : x, \end{array}$$

i.e., $47 : 48 :: 4794 : x$;

$$\therefore \; x = \text{R}\tfrac{48 \times 4794}{47} = \text{R}4896. \quad \textit{Ans.}$$

Example 5. If 8 oxen or 6 horses eat the grass of a field in 10 days, in how many days will 5 oxen and 4 horses eat it ?

oxen oxen horses

$$8 : 5 :: 6 : x,$$

$$\therefore\ x = \tfrac{5 \times 6}{8} \text{ horses} = \tfrac{15}{4} \text{ horses.}$$

$\therefore$ 5 oxen and 4 horses will eat as much as $(\frac{15}{4}+4)$ or $\frac{31}{4}$ horses.

horses horses days

$$\text{Now,}\quad \tfrac{31}{4} : 6 :: 10 : x,$$

$$\therefore\ x = \tfrac{6 \times 10 \times 4}{31} \text{ days} = 7\tfrac{23}{31} \text{ days.} \quad \textit{Ans.}$$

Example 6. *A* can do a piece of work in 7 days, and *B* can do it in 9 days : how long will *A* and *B*, working together, take to do the work ?

A can do $\frac{1}{7}$ of the work and *B* can do $\frac{1}{9}$ of the work in 1 day ; $\therefore$ *A* and *B* together can do $(\frac{1}{7}+\frac{1}{9})$ or $\frac{16}{63}$ of the work in 1 day.

work work day

$$\tfrac{16}{63}$$

$$\therefore\ x = \tfrac{63}{16} \text{ days} = 3\tfrac{15}{16} \text{ days.} \quad \textit{Ans.}$$

Example 7. At what time between 2 and 3 o'clock are the hands of a clock at right angles to each other ?

The minute-hand gains 11 divisions on the hour-hand in 12 minutes ; and here it has to gain (10+15) or 25 divisions.

div. div. min.

$$11 : 25 :: 12 : x,$$

$$\therefore\ x = \tfrac{25 \times 12}{11} \text{ min.} = 27\tfrac{3}{11} \text{ min. ;}$$

$\therefore$ the two hands will be at right angles to each other at $27\frac{3}{11}$ minutes past 2.

Example 8. *A* can beat *B* by 40 yards in a mile race ; *B* can beat *C* by 20 yards in a mile race ; if *A* and *C* run a mile, by how much will *A* win ?

While *A* runs 1760 yd., *B* runs 1720 ;

and .... *B* ...... 1760 yd., *C* ...... 1740.

$$1760 : 1720 :: 1740 : x,$$

$$i.e.,\quad 44 : 43 :: 1740 : x ;$$

$$\therefore\ x = \tfrac{43 \times 1740}{44} \text{yd.} = 1700\tfrac{5}{11} \text{ yd.}$$

$\therefore$ While *B* runs 1720 yd., *C* runs $1700\frac{5}{11}$ yd. ; but while *B* runs 1720 yd., *A* runs 1760 yd. ; $\therefore$ while *A* runs 1760 yd., *C* runs $1700\frac{5}{11}$ yd. $\therefore$ *A* will win by $(1760-1700\frac{5}{11})$ or $59\frac{6}{11}$ yd.

Example 9. A starts from P to walk to Q, a distance of $51\frac{3}{4}$ miles, at the rate of $3\frac{3}{4}$ miles an hour; an hour later B starts from Q for P and walks at the rate of $4\frac{1}{4}$ miles an hour: when and where will A meet B?

A has already gone $3\frac{3}{4}$ miles when B starts. Of the remaining 48 miles, A walks $3\frac{3}{4}$ and B walks $4\frac{1}{4}$ in one hour; that is, they together pass over $(3\frac{3}{4}+4\frac{1}{4})$ or 8 miles in one hour.

$$\begin{array}{ccccccc} \text{miles} & & \text{miles} & & \text{hour} & & \\ 8 & : & 48 & :: & 1 & : & x, \end{array}$$

$$\therefore\ x=\tfrac{48}{8}\text{ hours}=6\text{ hours}.$$

$\therefore$ A meets B in 6 hours after B started. And therefore they meet at a distance of $4\frac{1}{4}\times 6$ or $25\frac{1}{2}$ miles from Q.

[For Examples for Exercise see Section xxxv.]

XXXIX. DOUBLE RULE OF THREE.

220. Complex problems which would require two or more applications of the Rule of Three are usually solved by a shorter method, commonly called the **Double Rule of Three.** The method will be best explained by means of examples.

Example 1. If 9 men can reap 6 acres in 10 days, how many men will reap 12 acres in 15 days?

$$\left.\begin{array}{lccc} \text{acres} & 6 & : & 12 \\ \text{days} & 15 & : & 10 \end{array}\right\} :: 9\text{ men} : x.$$

We denote the answer by x and place it for the 4th term, and place 9 men (which is of the same kind as the answer) for the 3rd term. We next take 6 acres and 12 acres (a pair of quantities of the same kind), and consider whether the answer will be greater or less than the 3rd term in the question "if 9 men can reap 6 acres, how many men will reap 12 acres, supposing the time to be the same in both cases?" and we find that the answer will be greater; we therefore place 12 acres for the 2nd and 6 acres for the 1st term. Then we take 10 days and 15 days (another pair of quantities of the same kind), and consider whether the answer will be greater or less than the 3rd term in the question "if 9 men can reap in 10 days, how many men will reap in 15 days, supposing the number of acres to be the same in both cases?" and we find that the answer will be less; we therefore place 10 days for the 2nd and 15 days for the 1st term, under those already obtained. We now multiply the numbers in the 1st term for the final 1st term and the numbers in the 2nd term for the final 2nd term. Thus

$$6\times 15 : 12\times 10 :: 9 : x,$$

$$\therefore\ x=\frac{12\times 10\times 9}{6\times 15}\text{ men}=12\text{ men}.\quad \textit{Ans.}$$

Note. Each pair of quantities of the same kind should be replaced by their measures in terms of the same unit.

Remark. Each additional pair of quantities of the same kind would be treated in a like manner.

Example 2. If 72 men can dig a trench, 324 yd. long, 12 yd. wide and 8 ft. deep, in 9 days of 12 hours each; how many men can dig a trench, 1458 yd. long, 40 ft. wide and 3 yd. deep, in 36 days of 9 hours each?

$$\left.\begin{array}{lccc} \text{ft. long} & 324\times3 & : & 1458\times3 \\ \text{ft. wide} & 12\times3 & : & 40 \\ \text{ft. deep} & 8 & : & 3\times3 \\ \text{days} & 36 & : & 9 \\ \text{hours} & 9 & : & 12 \end{array}\right\} :: 72 \text{ men} : x,$$

$$\therefore\ x=\frac{1458\times3\times40\times3\times3\times9\times12\times72}{324\times3\times12\times3\times8\times36\times9}\text{men}=135 \text{ men. } \textit{Ans.}$$

Or better thus:

$$\left.\begin{array}{llcl} \text{cu. ft.} & (324\times3)\times(12\times3)\times8 & : & (1458\times3)\times40\times(3\times3) \\ \text{hours} & 36\times9 & : & 9\times12 \end{array}\right\} :: 72 : x.$$

Example 3. If 10 men can perform a piece of work in 24 days, how many men will perform another piece of work 3 times as great in $\frac{1}{5}$ of the time?

$$\left.\begin{array}{lccc} \text{work} & 1 & : & 3 \\ \text{days} & \frac{24}{5} & : & 24 \end{array}\right\} :: 10 \text{ men} : x,$$

$$\therefore\ x=\frac{3\times24\times10}{\frac{24}{5}}\text{men}=\frac{3\times24\times10\times5}{24}\text{men}=150 \text{ men. } \textit{Ans.}$$

Example 4. If the sixpenny loaf weigh 8 oz. when wheat is 15*s*. a bushel, what ought a bushel of wheat to be when the fourpenny loaf weighs 12 oz.?

$$\left.\begin{array}{lccc} \text{pence} & 6 & : & 4 \\ \text{ounces} & 12 & : & 8 \end{array}\right\} :: 15s. : x,$$

$$\therefore\ x=\frac{4\times8\times15}{6\times12}s.=\frac{20}{3}s.=6s.\ 8d. \ \textit{Ans.}$$

Example 5. If 5 cannon, which fire 3 rounds in 5 minutes, kill 135 men in 1½ hours, how many cannon, which fire 5 rounds in 6 minutes, will kill 250 men in 1 hour?

[The first 5 cannon, each firing 54 rounds, kill 135 men; it is required to find how many cannon, each firing 50 rounds, will kill 250 men.]

$$\left.\begin{array}{lccc} \text{rounds} & 50 & : & 54 \\ \text{men} & 135 & : & 250 \end{array}\right\} :: 5 \text{ cannon} : x,$$

$$\therefore\ x=\frac{54\times250\times5}{50\times135}\text{cannon}=10 \text{ cannon. } \textit{Ans.}$$

221. Examples in Double Rule of Three can be worked more conveniently in a little different manner. In this method the first *work* and second *work* are respectively taken for the third and fourth terms of the proportion, and the first *cause* and second *cause* respectively for the first and second terms; for, the ratio of the two *causes* is equal to the ratio of the corresponding *works*. We shall apply the method to the first two of the foregoing examples.

Example 1. 9 men in 10 days will do the same amount of work as (9×10) men will do in 1 day; and x men in 15 days will do the same amount of work as $(x \times 15)$ men will do in 1 day.

$$\therefore \quad 9 \times 10 : x \times 15 :: 6 : 12,$$

$$\therefore \quad x \times 15 \times 6 = 9 \times 10 \times 12,$$

$$\therefore \quad x = \frac{9 \times 10 \times 12}{15 \times 6} \text{ men} = 12 \text{ men.} \quad \textit{Ans.}$$

Example 2.

$$72 \times 9 \times 12 : x \times 36 \times 9 :: (324 \times 3) \times (12 \times 3) \times 8 : (1458 \times 3) \times 40 \times (3 \times 3),$$

$$\therefore \quad x = \frac{72 \times 9 \times 12 \times 1458 \times 3 \times 40 \times 3 \times 3}{36 \times 9 \times 324 \times 3 \times 12 \times 3 \times 8} \text{ men.}$$

$$= 135 \text{ men.} \quad \textit{Ans.}$$

[For Examples for Exercise see Section xxxvi.]

MISCELLANEOUS EXAMPLES. 139.

1. Find the least number which being added to 1409 will make the result divisible by 23.

2. A boy receiving R2. 4*a*. a week has 8*a*. stopped every fourth week; if there are 48 weeks in the school-year, how much does he get in 2 years?

3. What are the prime factors in 45090045, and what is the smallest whole number by which it must be multiplied in order to become a perfect square?

4. Find the least fraction which, being added to $\frac{1}{5} + \frac{1}{6} \div \frac{1}{7} - \frac{1}{4} \times \frac{1}{8} - \frac{1}{3}$, shall make the result an integer.

5. Find, by Practice, the value of $37\frac{1}{2}$ md. of sugar at R9. 13*a*. 6*p*. per md.

6. If 27 men can perform a piece of work in 15 days, how many men must be added to the number that the work may be finished in $\frac{7}{8}$ of the time?

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7. Find the greatest and least numbers of four digits exactly divisible by 34.

8. I distribute a sum of money among 32 men, giving R50. 7*a*. 6*p*. to the first, R51. 7*a*. 6*p*. to the next, R52. 7*a*. 6*p*. to the next,

and so on, increasing the sum by R1 each time ; how much would each get if I divided the money equally ?

9. Determine the least number, by which 378 must be multiplied to produce a number exactly divisible by 336.

10. A screw advances ·392 of an inch at each turn ; how many turns must be taken for it to advance 9·8 inches ?

11. Find, by Practice, the cost of 35 cwt. 2 qr. 7 lb. at £7. 11*s.* 4*d.* per cwt.

12. If 12 iron bars, each 4 ft. long, 3 in. broad and 2 in. thick, weigh 576 lb., how much will 11 weigh, each 6 ft long, 4 in. broad and 3 in. thick ?

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13. The population of a town is 5720, and there are 320 more men than women ; how many are there of each sex ?

14. A labourer, who works on week days only, earns 7*a.* 9*p.* a day ; supposing that the 1st of January 1885 was on a Sunday, find the amount of his earnings during the year.

15. Four bells ring at intervals of 3, $3\frac{1}{4}$, $3\frac{1}{3}$ and $3\frac{3}{4}$ seconds respectively, beginning together : how often during 24 hours will the four bells ring together again ?

16. By what number must $\frac{1}{2}+\frac{1}{3}$ of $\frac{1}{8}-\frac{1}{4}$ be multiplied in order to produce the least possible integer ?

17. A certain number of men subscribed £63. 0*s.* 9*d.*, each subscribing as many pence as there were men ; how many men were there ?

18. If $\cdot 4\dot{2}8571\dot{}$ of a barrel of beer be worth ·72 of £2. 10*s.*, what is the value of ·625 of the remainder ?

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19. To the fourth part of a certain number I add 79, and obtain 100 as the sum ; what is the number ?

20. Divide R101. 15*a.* 3*p.* among 20 men, giving to each of 5 of them twice as much as to each of the others.

21. 720 gallons of cocoanut oil and 450 gallons of castor oil are to be put into an exact number of barrels, all of the same size, without mixing the two oils together : find the least number of barrels required.

22. Express $\frac{3}{8}$ of 7*s.* 6*d.* + 1·25 of 5*s.* − ·54$\frac{4}{5}$ of 9*s.* 2*d.* as the decimal of £10.

23. The perimeter of a rectangle is 110 ft. ; the difference of two sides is 11 ft. : find its area as the decimal of an acre.

24. If a man can perform a journey of 170 miles in $4\frac{1}{4}$ days of 11 hours each, in how many days of $8\frac{3}{4}$ hours each, will he perform a journey of 470 miles ?

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25. To a certain number I add 3, and multiply the sum by 4, then divide the product by 5, and get 7 as quotient and 1 as remainder : what is the number ?

26. A man bought 40 pieces of ribbon, all equally long, for ₨137. 8*a.* at 2*a.* 9*p.* a yard ; how many inches were there in each piece ?

27. What is the least debt in dollars (4*s.* 2*d.* each) that can be paid in moidores ?

28. What is the capacity of a vessel, out of which, when it is half full, $4\frac{1}{2}$ gallons being drawn, there remains $\frac{1}{8}$ of the whole content ?

29. A square space, containing 113 sq. yd. 7 sq. ft, is to be lengthened by 3 ft. in one of its dimensions, and to be shortened by 3 ft. in the other ; what will then its area be ?

30. If a person walks 7 miles in $2\frac{1}{2}$ hours, how long will a second person take to walk 10 miles, supposing that the first walks $2\frac{3}{4}$ miles while the second walks $2\frac{1}{4}$?

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31. Fourteen years ago a man was six times as old as his son whose present age is 20 years ; what is the present age of the father ?

32. A man buys 20 seers of milk at 3*a.* 6*p.* per seer ; how much water must he add to it that he may gain ₨1. 4*a.* by selling the mixture at 3*a.* per seer ?

33. I had coins of one kind weighing 2205 grains ; and of this I spent coins weighing 1035 grains : show that a single coin cannot weigh more than 45 grains ?

34. Two clocks begin to strike 12 together ; one strikes at an interval of 2·916 seconds, the other, of $2·08\frac{1}{3}$ seconds ; what decimal of a minute is there between their seventh strokes ?

35. Find the cost of painting the walls of a square room, 10 ft. high and 16 ft. long, with one door 8 ft. by 4 ft., and 2 windows, each 5 ft. by 2, the amount saved by each window being ₨1. 14*a.* What additional height would increase the cost by ₨12 ?

36. A merchant of Calcutta indented from London goods worth £226, and paid £34 for freight and packing. He sold half the goods at a gain of 2 annas per rupee ; at what gain per rupee must he sell the remainder that he may clear ₨500 on the whole outlay ? [₨1 = 1*s.* $7\frac{1}{2}$*d.*]

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37. Find the greatest fraction, the numerator of which is composed of 3, 5, 1, 0 and the denominator of 3, 2, 8, 0.

38. Two persons buy 600 oranges each at 24 for a half-rupee ;

one sells them at 5*a*. 6*p*. a dozen, and the other at 8*a*. 3*p*. a score ; who gains more, and by how much ?

39. A number is exactly divisible by 7 and by 13, and it is known that the number is between 400 and 500 ; what is the number?

40. What fraction of $\frac{3}{4}$ of a rupee is $\frac{4}{5}$ of R5 ; and what fraction of their sum is their difference ?

41. Find the length of the inner edge of a cubical cistern which will hold 256 lb. of water, supposing that a cu. ft. of water weighs 1000 oz.

42. A person after paying an income-tax of 1 anna in the R, devotes $\frac{1}{16}$ of the remainder of his income to purposes of charity, and finds that he has R5175 left ; what is his income ?

43. A person has a number of oranges to dispose of ; he sells half of what he has and one more to *A*, half of the remainder and one more to *B*, half of the remainder and one more to *C* ; by which time he has disposed of all he had : how many had he at first ?

44. A certain number of men, twice as many women and three times as many children earned R16. 2*a*. in 3 days ; each man earned 12*a*., each woman 8*a*. and each child 5*a*. a day : how many women were there ?

45. Find the greatest weight that will measure (*i.e.*, divide exactly) a lb. avoir. and a lb. troy.

46. If $\frac{1}{7}\frac{3}{8}$ of a number exceed $\cdot 8\dot{3}$ of half the number by ·2002, what must the number be ?

47. How many bricks, 6 in. by 3 in. by 3 in., will be required for a wall, 16 ft. by 10 ft. by 2 ft., allowing $\frac{1}{16}$ of the space for mortar ?

48. A creditor received on a debt of R3600 a dividend of 9*a*. 10*p*. in the R ; and a further dividend of 6*a*. 8*p*. upon the remainder. What did he receive altogether, and what fraction was it of the entire debt ?

49. *A* has R150, *B* has R120 ; if *C* had R16 more than what he has, then *B* and *C* together would have as much as *A* : how much has *C* ?

50. Divide £30. 10*s*. 8*d*. into two sums of money, one of which contains as many shillings as the other contains fourpences.

51. 378 oranges and 462 mangoes are to be distributed among boys so that each boy gets as many oranges and as many mangoes as any other boy ; find the largest possible number of boys, and the least possible number of fruits each boy may get.

52. What number is greater than its fifth part by $\frac{1}{5}$?

53. Find how much card-board is required to make a cubical box and its cover, the edge of the box is 9 in., and the rim of the cover extends 3 in. deep down each side.

54. A work can be completed in 36 days by 30 men working 6 hours a day ; in what time would 18 men and 60 women, working 9 hours a day, complete it, supposing that 3 men can do as much work as 5 women ?

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55. A gentleman's monthly expenses are R150 less than his income ; if his income be increased by R100 a month and expenses decreased by R50, how much will he be able to save in a year ?

56. Three persons *A*, *B*, *C* start on a tour, each with £20 in his pocket, and agree to divide their expenses equally. When they return, *A* has £3. 11*s*. 9*d*., *B* has £2. 5*s*. and *C* has 17*s*. 3*d*. What ought *A* and *B* to pay to *C* to settle their accounts ?

57. A man walks at the rate of 128 yards per minute ; find the least whole number of minutes he will take to walk over an exact number of miles.

58. Simplify $(3\cdot5-2\cdot\dot{3})(3\cdot5+2\cdot\dot{3})\div3\cdot5$ of $2\cdot\dot{3}\times32\cdot5\dot{3}$.

59. The external dimensions of an open box are 5 ft., $4\frac{1}{2}$ ft. and 3 ft. ; find the cost of painting the outside at 3 annas per sq. yd. What will be the cost of painting the inside at the same rate, if the box is made of $\frac{1}{2}$-inch plank ?

60. Three men can do as much work as 5 boys ; the wages of three boys are equal to those of two men. A work, on which 40 boys and 15 men are employed, takes 8 weeks and costs £350 ; how long would it take if 20 boys and 20 men were employed, and how much would it cost ?

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61. What quantity of water must an inn-keeper add to a barrel of beer, which cost him £50, to reduce the price to £1. 5*s*. a gallon ?

62. A certain number of men mow 4 acres in 3 hours, and a certain number of others mow 8 acres in 5 hours ; how long will they be mowing 11 acres, if they all work together ?

63. At 10 minutes to 2 in the afternoon a clock is 55 seconds slow, and at 6 in the evening it is 30 seconds slow ; at what hour will it show true time ?

64. A train leaves Calcutta at 7 A. M. for Goalundo, 153 miles distant, and travels at the rate of 20 miles an hour ; another train leaves Goalundo for Calcutta at 11-30 A. M. and travels at the rate of 22 miles an hour ; when, and where, will the trains pass each other ?

65. A cistern, 6 ft. long, 5 ft. wide and 4 ft. deep, contains

pulp for making paper. If $\frac{2}{3}$ of the volume of the pulp be lost in the process of drying, how many sheets of paper, 16 in. by 10 in., will be obtained, if 400 sheets in thickness go to an inch ?

66. If 7 men and 5 boys can reap 168 acres in 18 days, how many days will 15 men and 5 boys take to reap 700 acres, one man being able to do three times as much work as a boy ?

67. Find the value of $\frac{3}{8}$ of a guinea + $\frac{6}{11}$ of 8*s.* 3*d.* + $\frac{3}{110}$ of £2. 15*s.* ; and reduce the result to the fraction of a guinea and a half.

68. Two pipes, *A* and *B* fill a cistern in 25 and 30 minutes respectively. Both pipes being opened, find when the first must be closed that the cistern may be just filled in 15 minutes.

69. If $\frac{1}{5}$ of a sheep be worth $\frac{2}{3}$ of a rupee, and $\frac{2}{7}$ of a sheep be worth $\frac{1}{14}$ of a cow, how much must be given for 106 cows ?

70. The cubic content of an open cistern, 6 ft. long and 4 ft. broad, is 20 cu. ft. ; what will be the cost of lining the inside of it at 1*s.* per sq. ft. ?

71. Two persons, walking at the rate of $3\frac{1}{2}$ and 4 miles per hour respectively, set off from the same place in opposite directions to walk round a park, and meet in 20 minutes. Find the length of the path round the park.

72. If it takes 120 men to supply, in 5 days' work, a fortress with provisions for 5 months, when the garrison is 650 strong, how many will be required to supply it in 3 days for 4 months, after the garrison has been reduced by 130 men ?

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73. A bag contains a certain number of shillings, twice as many sixpenny pieces and 3 times as many fourpenny pieces ; the whole sum amounts to 2 guineas : find the number of each.

74. A room, whose height is 9 ft., and length twice its breadth, takes 189 yards of paper, 2 ft. wide, for its four walls ; find its length.

75. *A* can do a piece of work in 20 days ; *A* and *B* together can do it in $11\frac{1}{9}$ days. *A* works alone for 8 days, *A* and *C* together for 6 days, and *B* finishes it in 3 days. Find in what time *B* and *C* together could do it.

76. One clock gains 8 min., and another loses 4 min., in 24 hours. They are set at right at noon on Sunday. Determine the time indicated by each clock when the one appears to have gained 12 minutes on the other.

77. The whole time occupied by a train 110 yards long, travelling at the rate of 30 miles an hour, in crossing a bridge is 12 seconds ; find the length of the bridge.

78. If a family of 9 persons spend ₨480 in 8 months, how much will serve a family (living upon the same scale) of 24 persons for 16 months?

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79. Simplify $\dfrac{£7.\ 6s.\ 8d.}{£3.\ 4s.} \times \dfrac{\frac{1}{2} - \frac{1}{3} \text{ of } \frac{1}{4} - \frac{1}{8}}{(\frac{1}{2} - \frac{1}{3}) \text{ of } (\frac{1}{4} - \frac{1}{8})}$.

80. A room twice as long as it is broad is carpeted at 9*s.* a sq. yd., and the walls are painted at 1*s.* 6*d.* a sq. yd., the respective costs being £44. 2*s.* and £8. 8*s.* Find the dimensions of the room.

81. A cistern would be filled by a tap, *A*, in $3\frac{1}{2}$ hours, or emptied by a tap, *B*, in 3 hours. The cistern being half full, *A* is turned on at 8 o'clock, and *B* at 15 min. to 9; find when the cistern will again be half full.

82. If 2 guineas make 3 napoleons, and 15 rix-dollars make 4 napoleons, and 6 ducats make 7 rix-dollars, how many ducats are there in £490?

83. A person rows a distance of 3 miles down a stream in 40 minutes, but without the aid of the stream it would have taken him an hour; what is the rate of the stream per hour? and how long would it take him to return against it?

84. A boat propelled by 6 oars which take 25 strokes per minute travels at the rate of $7\frac{1}{2}$ miles an hour; find the rate of a boat propelled by 4 oars which take 32 strokes per minute; the work done by each oar during one stroke in the latter case being a quarter as much again as in the former case.

85. A wagon, loaded with 1246 equal packages, weighs 26 tons 14 cwt.; if the wagon itself weighs twice as much as the packages, find the weight of each package.

86. *A* did $\frac{3}{8}$ of a piece of work in 6 hours, *B* did $\frac{3}{4}$ of what remained in 2 hours and *C* finished it in half an hour. How long would they have been doing the whole if they had worked together?

87. A clock loses 5 minutes a day. It shows correct time at noon on a Monday. After how many days will it again show correct time on a Monday?

88. A privateer, running at the rate of 10 miles an hour, discovers a ship, 18 miles off, making way at the rate of 8 miles an hour; how many miles can the ship run before she is overtaken?

89. If the wages of 25 men amount to ₨766. 10*a.* 8*p.* in 16 days, how many men must work 24 days to receive ₨1035, the daily wages of the latter being one-half those of the former?

90. 55 gallons of a mixture of wine and water contain 5 gallons more wine than water ; find the ratio of wine to water in the mixture.

91. Bring $\left\{\left(\frac{5\frac{1}{4} - \frac{1}{3} \text{ of } 2\frac{5}{8}}{\frac{3}{8} \times 4\frac{1}{3} + \frac{1}{12}} + \frac{2\frac{3}{7}}{4\frac{1}{7}}\right) \div 21\frac{28}{29} \times 3\frac{19}{206}\right\}$ cwt. to the fraction of $4\frac{1}{7}$ tons.

92. *A* can do half a piece of work in 3 hours, being twice as much as *B* can do ; *A*, *B* and *C* can together do the whole in $2\frac{1}{2}$ hours : in how many hours will *C* do a piece of work which *B* can do in 9 hours ?

93. How many seconds will a train, 184 feet in length, travelling at the rate of 21 miles an hour, take in passing another train, 223 feet long, proceeding in the same direction at the rate of 16 miles an hour ?

94. *A* can give *B* 20 yards' start in a mile race and can give *C* 40 yards' start ; how much start can *B* give *C* in a mile race ?

95. A piece of work must be finished in 36 days, and 15 men are set to do it, working 9 hours a day ; but after 24 days it is found that only $\frac{3}{5}$ of the work is done. If 3 additional men be then put on, how many hours a day will they all have to labour, in order to finish the work in time ?

96. Two equal wine glasses are filled with mixtures of wine and water in the ratios of 2 of wine to 3 of water and 3 of wine to 4 of water ; when the contents are mixed in a tumbler, find the strength of the mixture.

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97. Divide ₨47 between *A*, *B* and *C* in such a manner that *B* may receive ₨2 more than 3 times, and *C* ₨3 more than 4 times, the amount to be received by *A*.

98. At what times between 2 and 3 are the hands of a clock $5\frac{1}{2}$ minute-divisions apart ?

99. Three boys agree to start together and run, until all come together again, round a circular court 15 yards in circumference. One runs at the rate of 6, the second, 7, and the third, 8 miles an hour. In how many seconds will the race end ?

100. In a game of skill *A* can give *B*, and *B* can give *C*, 10 points out of a game of 50 ; how many should *A* give *C* ?

101. If 7 cows and 20 sheep be worth £12, and 3 cows and 16 sheep be worth £7, find the price of a cow and of a sheep.

102. Two equal wine glasses are respectively $\frac{1}{2}$ and $\frac{1}{4}$ full of wine ; they are then filled up with water, and the contents mixed in a tumbler : find the ratio of wine to water in the tumbler.

103. Express $\cdot\dot{6}$ of R17. 8*a*. + $\cdot\dot{5}$ of £1. 14*s*. 6*d*. as the fraction of R170, a rupee being worth 2 shillings.

104. *A* can do a piece of work in 8 days, which *B* can destroy in 3. *A* has worked 6 days, during the last 2 of which *B* has been destroying ; how many days must *A* now work alone in order to complete his task ?

105. A train 110 yd. long overtook a person walking along the line at the rate of 3 miles an hour, and passed him completely in 9 seconds ; afterwards it overtook another person and passed him in $9\frac{3}{8}$ seconds. At what rate was this second person walking ?

106. In a hundred yards' race *A* can give *B* four and *C* five yards' start : if *B* were to race *C*, giving him 1 yard in a hundred, which would win ?

107. If 6 men and 2 boys can reap 13 acres in 2 days, and 7 men and 5 boys can reap 33 acres in 4 days, how long will it take 2 men and 2 boys to reap 10 acres ?

108. Gold and silver are mixed together in a mass of 30 oz., so that for every 6 parts of gold there are 4 parts of silver. How much gold must be added to the mass, so that for every 5 parts of gold there may be 3 parts of silver ?

109. A publican bought 10 gallons of wine at £1 . 7 . 6 per gallon ; he mixed some water and filled quart bottles with it : how much water must have been added, supposing that the cost price of the contents of each bottle was thereby reduced to 5*s*. $8\frac{3}{4}$*d*. ?

110. If 12 oxen be worth 29 sheep, 15 sheep worth 25 hogs, 17 hogs worth 3 loads of wheat, and 8 loads of wheat worth 13 loads of barley ; how many loads of barley must be given for 340 oxen ?

111. *A* and *B* are two spouts attached to a cistern. *A* can fill it in 10 min., and *B* can empty it in 15 min. If *A* and *B* be opened alternately for 1 minute each, in what time will the cistern be filled ?

112. A race course is one mile long : *A* and *B* run a race and *A* wins by 80 yards ; *A* and *C* run over the same course and *A* wins by 20 seconds ; *B* and *C* run and *B* wins by 5 seconds. In what time can *A* run a mile ?

113. If I can walk a certain distance in 112 days when I rest 5 hours each day, how long will it take me to walk twice as far, if I walk twice as fast and rest twice as long each day ?

114. A cask contains 12 gallons of a mixture of wine and water in the ratio of 3 to 1 ; how much of the mixture must be drawn off, and water substituted for the mixture in the cask to become half and half ?

115. A rectangular court is 50 yards long and 30 yards broad. It has paths joining the middle points of the opposite sides, of 6 ft. in breadth, and also has within it a path of the same breadth running all round it. The remainder is covered with grass. If the cost of the pavement be 1*s* 8*d*. per sq. ft. and of the grass 3*s*. per sq. yd., find the whole cost of laying out the court.

116. To complete a piece of work, *A* would take twice as long as *B* and *C* together, and *B* 3 times as long as *A* and *C* together; *A*, *B*, *C* together can do it in 12 days. In what time could each do it by himself?

117. A down-train usually travels at the rate of 30 miles an hour and meets an up train 50 miles from the terminus. On one occasion, on account of an accident, it only went at the rate of 20 miles an hour and met the up-train $41\frac{2}{3}$ miles from the terminus. Find the speed of the up-train.

118. *A* can walk 5 miles an hour, and the rate at which *A* and *B* walk are in the ratio of 7 to 6: how many seconds' start must *A* give *B* that he may just beat him in a 3-mile race?

119. If 5 pumps, each having a length of stroke of 3 feet, working 15 hours a day for 5 days, empty the water out of a mine; how many pumps with a length of stroke of $2\frac{1}{2}$ feet, working 10 hours a day for 12 days, will be required to empty the same mine; the strokes of the former set of pumps being performed four times as fast as the other?

120. If 7 horses and 12 cows cost as much as 10 horses and 6 cows, compare the prices of a horse and cow.

XL. DIVISION INTO PROPORTIONAL PARTS.

222. To divide a given quantity into *proportional parts* is to divide it into parts which shall be proportional to certain given numbers.

Example 1. Divide R873 among *A*, *B*, *C*, so that their shares may be in the proportion of 2, 3 and 4.

If we divide R873 into 9 (*i. e.*, 2+3+4) equal parts, then *A* will have 2, *B* will have 3 and *C* will have 4 of these parts.

Hence *A*'s share $= \text{R}\frac{873}{9} \times 2 = \text{R}194$.

B's share $= \text{R}\frac{873}{9} \times 3 = \text{R}291$.

C's share $= \text{R}\frac{873}{9} \times 4 = \text{R}388$.

Example 2. Divide £287 into parts proportional to $1\frac{1}{2}$, 2 and $3\frac{1}{3}$.

$$1\frac{1}{2} : 2 : 3\frac{1}{3} = \frac{3}{2} : 2 : \frac{10}{3} = \frac{9}{6} : \frac{12}{6} : \frac{20}{6} = 9 : 12 : 20.$$

Now proceed as in the preceding example.

Example 3. A certain sum of money was divided between A, B, C in the proportion of 5, 6 and 9 ; A received £45 ; what was the sum divided ?

Since $5+6+9=20$, if the whole sum were divided into 20 equal parts, A's share would contain 5 of these parts. Hence the value of one part $=£\frac{45}{5}$; $\therefore$ the whole sum $=£\frac{45}{5}\times 20=£180$.

Example 4. Divide R50 among A, B, C, so that B's share may be half as much again as A's. and C's share $\frac{2}{3}$ of A's and B's together.

B's share $=1\frac{1}{2}$ of A's share ;

$\therefore$ A's share $+$ B's share $=$ A's share $+1\frac{1}{2}$ of A's share

$=(1+1\frac{1}{2})$ of A's share $=2\frac{1}{2}$ of A's share ;

$\therefore$ C's share $=\frac{2}{3}$ of $2\frac{1}{2}$ of A's share $=\frac{5}{3}$ of A's share ;

$\therefore$ A's share : B's : C's $=1:1\frac{1}{2}:\frac{5}{3}$; etc.

Example 5. Divide 52 into 3 parts such that $\frac{1}{6}$ of the first part $=\frac{1}{3}$ of the second part $=5$ times the third part.

$\frac{1}{3}$ of the 2nd part $=\frac{1}{6}$ of the 1st part,

$\therefore$ the 2nd part $=\frac{3}{6}$ of the 1st part.

Again, 5 times the 3rd part $=\frac{1}{6}$ of the 1st part,

$\therefore$ the 3rd part $=\frac{1}{30}$ of the 1st part,

$\therefore$ 1st part : 2nd part : 3rd part

$=$ 1st part : $\frac{3}{6}$ of the 1st part : $\frac{1}{30}$ of the 1st part

$=1:\frac{3}{6}:\frac{1}{30}$; etc.

Example 6. R82 is given to 5 men, 8 women and 10 boys, in such a way that a woman is to receive twice as much as a boy, and a man as much as a woman and a boy together ; what do the women receive ?

8 women receive as much as 16 boys ;

and 5 men receive as much as 5 women and 5 boys,

or as 10 boys and 5 boys,

or as 15 boys ;

$\therefore$ men's share : women's : boys' $=15:16:10$; etc.

Example 7. How many rupees, half-rupees and quarter-rupees, of which the numbers are proportional to 3, 4 and 5, are together worth R90 ?

Value of three groups of coins are

as 3 rupees : 4 half-rupees : 5 quarter-rupees,

or as 12 quarter-rupees : 8 quarter-rupees : 5 quarter-rupees,

or as 12 : 8 : 5 ;

∴ the amount in rupees $= R\frac{50}{25} \times 12 = R24$;

the amount in half-rupees $= R\frac{50}{25} \times 8 = R16$;

and the amount in qr.-rupees $= R\frac{50}{25} \times 5 = R10$.

Therefore there are 24 rupees, 32 half-rupees and 40 qr.-rupees.

Example 8. Divide £100 between A, B, C, D, so that A's share : B's $= 2 : 3$, B's : C's $= 4 : 5$ and C's : D's $= 7 : 8$.

We find as in *Ex.* 4, Art. 216, that the shares of A, B, C, D are proportional to 56, 84, 105 and 120 ; etc.

EXAMPLES. 140.

1. Divide R15. 10*a*. into parts proportional to 1, 2, 3, 4.

2. Divide £18. 9*s*. into parts proportional to $\frac{3}{8}$, $2\frac{1}{2}$, 1, $\frac{1}{3}$.

3. Divide 26 tons in the proportion of 3·5, 2·25, $3\frac{1}{3}$, $3\frac{1}{12}$.

4. Divide $532\frac{1}{2}$ into parts which shall have the same ratio to one another as $\frac{1}{2}$, $\frac{2}{3}$, $\frac{3}{4}$, $\frac{4}{5}$, $\frac{5}{6}$.

5. Divide £4. 17*s*. 6*d*. into two parts one of which is $\frac{5}{8}$ of the other.

6. A sum of money was divided into parts proportional to $3\frac{3}{4}$, 4, 5·5 ; the smallest part was R30 ; what was the sum divided ?

7. A sum of money was divided between A, B, C in proportion to their ages which were 10, 12, 13 years respectively ; A's share was £55 ; find the other shares.

8. Gunpowder is composed of saltpetre, sulphur and charcoal, in parts proportional to 75, 10 and 15 ; how many pounds of charcoal are there in 6 cwt. of gunpowder ?

9. How much of the above gunpowder can be made with 25 lb. of sulphur ?

10. In a certain battle an army lost 4 men wounded and 2 killed out of every 25, and it mustered 38,000 men unhurt ; what was the number of men in the army at first ?

11. Divide R90 between three persons, so that for every rupee given to the first, the second may get 12 annas and the third may get 8 annas.

12. Divide R36 between A, B, and C, so that A gets $\frac{3}{4}$ of B's share, and C gets $\frac{2}{3}$ of A's share.

13. Divide ₹360 among A, B, C, so that A may get 3 times as much as B, and B and C together $\frac{1}{2}$ as much as A.

14. Divide ₹32 between A, B, C, so that A may receive 3 times as much as B, and C $\frac{1}{3}$ of what A and B together receive.

15. Divide £14 between A and B, so that $\frac{1}{2}$ of A's money may be equal to $\frac{2}{3}$ of B's.

16. Divide 30 into 3 parts such that $\frac{1}{3}$ of the first part $=\frac{2}{5}$ of the second $=\frac{1}{2}$ of the third.

17. ₹21 is divided between A, B, C; A's share is $\frac{2}{3}$ of B's; it is also $\frac{2}{5}$ of B's and C's together; find each one's share.

18. Divide £1. 13*s.* $4\frac{1}{2}$*d.* between A, B, C, D, so that A's share may be $\frac{3}{10}$ of D's, C's share $\frac{3}{10}$ of A's, and B's share the sum of A's and C's.

19. Divide £3. 6*s.* between 5 men, 7 women and 10 boys, so that each woman may have $\frac{3}{5}$ of each man's share, and each boy $\frac{2}{3}$ of each woman's share.

20. ₹110 is to be divided among 10 men, 16 women and 20 children: if each man's share is to be equal to the shares of 2 women and the 16 women are to have twice as much as the 20 children, how much will each woman receive?

21. A number of men, women, and children are in the proportion of 3, 4, 5: divide £3 5*s.* 3*d.* among them, so that the shares of a man, a woman and a child may be proportional to 4, 3, 1.

22. Divide £39 among A, B, C, so that A's share : B's share $= 3 : 2$, B's share : C's share $= 4 : 3$.

23. A certain kind of brass is composed of copper, zinc, lead and tin; the ratio of copper to zinc is $1 : 2$, of zinc to lead $3 : 5$ and of lead to tin $7 : 8$; find the quantity of zinc in 1 cwt. of the brass.

24. Four towns are to provide according to their population a contingent of 140 men. The populations of the towns are 1058, 1587, 2116 and 2645 respectively; find the number of men to be provided by each town.

25. 700 coins consist of rupees, half-rupees and quarter-rupees, the values of the rupees, the half-rupees and the quarter-rupees are as $2 : 3 : 5$; find the number of the rupees.

26. How many rupees, eight-anna pieces and four-anna pieces, of which the numbers are proportional to $2\frac{1}{2}$, 3 and 4, are together worth ₹80?

27. If 2 men do as much work as 5 women, and 6 women as much as 10 children, divide a week's wages of ₹38 among 8 men, 9 women and 15 children.

28. The sum of three fra. ons is $\frac{122}{105}$; 14 times the first = 15 times the second = 18 times the third : find the fractions.

29. Divide R142 among A, B, C, so that for every R5 given to A, B may get R3, and for every R7 given to B, C may get R5.

30. Areas of circles are to one another as the squares of their radii. Divide a circle of 1 ft. radius into three equal parts by concentric circles.

31. If the weight of pure silver and of alloy in a rupee be in the ratio of 11 to 1, and the price of pure silver be R2. 10. $5\frac{1}{11}$ per oz. avoir., find the weight of a rupee (in grains) supposing its value to be that of pure silver it contains.

32. An estate is divided amongst 3 persons in the ratio of 7, 8 and 10. Find the value of the estate when R2500 added to the largest share would make it equal to half of the whole.

33. A number of mangoes is to be divided amongst 4 persons in shares which are as $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{5}$ and $\frac{1}{6}$; what must the number *at least* be that this may be done without cutting any of the mangoes?

XLI. FELLOWSHIP OR PARTNERSHIP.

223. Suppose that three persons A, B, C are partners in trading, and that A has a capital of R3000 in the business, B has R5000 and C has R6000; and they gain R1400 : how should the profit be divided?

It is obvious that the profit must be divided into parts proportional to 3000, 5000 and 6000; which may be done by the method explained in the preceding section.

The above is an example of what is called **Simple Fellowship**, the capitals contributed by the several partners being supposed to continue in the business for the same period of time.

224. Suppose, again, that A, B, C are partners in trading, and that A has a capital of R3000 in the business for 3 months, B has R5000 for 6 months, and C has R6000 for 7 months, at the end of which time the gain is R720 : how should this be divided?

Now, a capital of R3000 employed for 3 months may be taken to be equivalent to a capital of R9000 (*i.e.*, R3000 × 3) employed for 1 month; R5000 for 6 months may be taken to be equivalent to R30000 (*i.e.*, R5000 × 6) for 1 month; and R6000 for 7 months, equivalent to R42000 (*i.e.*, R6000 × 7) for 1 month. Hence the profit must be divided in the proportion of 9000, 30000 and 42000; which may be done in the usual way.

Consequently, if the capitals of partners be employed for different periods of time, the period of time must be made the same

for all, by multiplying each capital by the measure of the corresponding period of time.

Note. In working, the several sums of money must be expressed in terms of the same unit, as also the several periods of time.

The above is an example of what is called **Compound Fellowship**, the capitals contributed by the several partners being employed in the business for different periods of time.

EXAMPLES. 141.

1. *A*, *B*, *C* enter into partnership; *A* furnishes ₹350, *B* ₹500 and *C* ₹750; what should be the share of each in ₹320 profit?

2. A bankrupt owes ₹2600 to two creditors, namely, ₹1200 to one, and ₹800 to the other; his assets are ₹700; what does each creditor lose?

3. *A*, *B*, *C*, *D* engage in business with a joint capital of £7550; at the end of a year *A* receives £200, *B* £235, *C* £120 and *D* £200; how much capital did *C* put in?

4. *A*, *B*, *C* are partners, *A* receiving $\frac{2}{3}$ of the profits, and *B* and *C* sharing the remainder equally. *A*'s income is increased by ₹75 when the profits rise from $\frac{1}{12}$ of the capital to $\frac{1}{10}$. Find the respective capitals invested.

5. *A* and *B* are partners in a business in which *A* has $7\frac{1}{2}$ annas share and *B* $8\frac{1}{2}$ annas; *B*, being the working partner, receives $\frac{1}{20}$ of all the profit, the rest is divided in proportion to the capital; what does *B* receive out of ₹6080?

6. *A*, *B*, *C* engage in business with a joint capital of £18000; *A* gives £2000 more than *B*, and *B* £2000 more than *C*; divide a profit of £1080 between them.

7. *A*, *B*, *C* enter into partnership: *A* puts in £70 for 5 months, *B* £50 for 6 months and *C* £30 for 8 months. They gain £44. 10*s*. How should the profit be divided?

8. *A*, *B*, *C* pasture in the same field. *A* has in it 10 oxen for 7 months, *B* has 12 oxen for 5 months, and *C* has 15 oxen for 3 months. The rent is ₹17. 8*a*. How much of the rent should each pay?

9. *A* starts business with a capital of £2200 on the 16th of April, and on the 3rd of July admits a partner *B* with a capital of £1800. The profits amount to £449. 16*s*. by the 31st of December. What is each person's share?

10. *D* and *E* become partners, *D* bringing ₹5400 and *E* ₹4300. At the end of 3 months *D* doubles his capital and a new partner *F* is admitted who brings ₹5700; and at the end of

5 months *E* trebles his capital. The year's profits amount to ₨1200 : how ought this to be divided ?

11. *A* and *B* start a business with capitals as 5 : 7. They withdraw respectively $\frac{2}{3}$ and $\frac{3}{4}$ of their capitals at the end of 4 months. At the end of the year a profit of £226 is divided ; find *A*'s share.

12. *A* and *B* entered into partnership with £700 and £600 respectively. After 3 months *A* withdrew $\frac{3}{7}$ of his stock but after 3 months more he put back $\frac{2}{3}$ of what he had withdrawn. The profits at the end of the year are £726 : how much of this should *A* receive ?

13. *A* and *B* start a business, *A* puts in double of what *B* puts. *A* withdraws $\frac{1}{3}$ of his stock at the end of 3 months but at the end of 7 months puts back $\frac{1}{4}$ of what he has taken out, when *B* takes out $\frac{1}{2}$ of his stock. *A* receives ₨300 profits at the end of the year ; what does *B* receive ?

14. *A* and *B* hire a meadow for 6 months. *A* puts in 21 cows for 4 months ; how many can *B* put in for the remaining 2 months, if he pays $\frac{5}{7}$ of what *A* pays ?

XLII. ALLIGATION.

225. The following are examples of **Alligation** or the mixing of things of the same kind but of different qualities.

Example 1. How must a grocer mix teas at 2*s*. 6*d*. a lb. and 3*s*. 9*d*. a lb. so that the mixture may be worth 3*s*. a lb. ?

When the mixture is made and sold at 3*s*. a lb., each lb. of the cheaper tea in it brings a gain of 6*d*, and each lb. of the dearer tea brings a loss of 9*d*. Therefore 9 lb. of the cheaper tea brings a gain of 54*d*. and 6 lb. of the dearer brings a loss of 54*d*. Hence, in order that there may be neither any gain nor any loss, for every 9 lb. of the cheaper tea we must take 6 lb. of the dearer ; therefore the proportion is 9 parts to 6, that is, ***the teas must be mixed in the inverse ratio of the differences of the two prices and mean price.***

Example 2. In what proportion should teas at 2*s*. 6*d*., 3*s*., 4*s*. 3*d*. and 4*s*. 9*d*., a lb. be mixed to make a mixture worth 4*s*. a lb. ?

The first two prices are under, and last two above, the mean price. We take equal quantities of the teas at the first two prices, and the mixture is worth 2*s*. 9*d*. a lb. ; we also take equal quantities of the teas at the last two prices, and the mixture is worth 4*s*. 6*d*. a lb. Now we mix these two mixtures as in *Ex*. 1, and we find that these must be taken in the proportion of 6 to 15 or 2 to 5. Consequently the teas are mixed in the proportion of 1, 1, $\frac{5}{2}$, $\frac{5}{2}$.

Note. Instead of taking equal quantities we might take the teas in any proportion to make the first two mixtures ; and consequently an example of this kind (in which the number of ingredients is more than two) may have an unlimited number of solutions.

Example 3. In what ratio must a grocer mix sugar at 6*a*. per seer with sugar at 4*a*. per seer so that by selling the mixture at 5*a*. 3*p*. per seer he may gain $\frac{1}{6}$ of his outlay?

$1\frac{1}{6}$ of the cost price of a seer of the mixture = 5*a*. 3*p*. ; ∴ cost price of a seer of the mixture = 5*a*. 3*p*. ÷ $1\frac{1}{6}$ = 4*a* 6*p*. Now proceeding as in *Ex*. 1, we find that sugar at 6*a*. per seer must be mixed with sugar at 4*a*. per seer in the ratio of (4*a*. 6*p*. − 4*a*.) to (6*a*. − 4*a*. 6*p*.), *i. e.*, of 1 to 3.

EXAMPLES. 142.

1. How must sugar at 4*a*. per seer be mixed with sugar at 5*a*. per seer to make a mixture worth 4*a*. 3*p*. per seer ?

2. In what ratio must tea worth 2*s*. 7*d*. per lb. be mixed with tea worth 3*s*. 8*d*. per lb. to make a mixture worth 3*s*. per lb. ?

3. Tea at 2*s*. 6*d*. per lb. is mixed with tea at 4*s*. 7*d*. per lb., and the mixture is sold for 3*s*. 5*d*. a lb. ; how were they mixed ?

4. In what ratio must a grocer mix coffee at 3*s*. per lb. with chicory at 7*d*. so that by selling the mixture at 2*s*. per lb. he may gain $\frac{1}{12}$ of his outlay ?

5. A grocer buys black tea at 2*s*. 6*d*. per lb. and green tea at 3*s*. 9*d*. per lb. ; how must he mix them so that by selling the mixture at 3*s*. per lb. he may gain $\frac{1}{8}$ of his outlay ?

6. In what proportion should water and wine at 12*s*. 6*d*. a gallon be mixed to reduce the price to 10*s*. a gallon ?

7. Currants at 5*d*. per lb. are mixed with currants at 9*d*. per lb. to make a mixture of 17 lb. worth 7*d*. per lb ; how many pounds of each are taken ?

8. A person bought 60 md. of rice of two different sorts for ₨153. 12*a*. The better sort cost ₨3 per md. and the worse ₨2. 4*a*. per md. How many maunds were there of each sort ?

9. A liquid *P* is $1\frac{3}{7}$ times as heavy as water, and water is $1\frac{2}{5}$ times as heavy as another liquid *Q* ; how much of the liquid *P* must be added to 7 gallons of the liquid *Q* so that the mixture may weigh as much as an equal volume of water ?

10. A mass of gold and silver weighing 9 lb. is worth £318. 13*s*. 0*d*. ; if the proportions of gold and silver in it were interchanged, it would be worth £129. 10*s*. 6*d*. ; supposing that the price of gold is £3. 17*s*. $10\frac{1}{2}$*d*. per oz., find the proportion of gold and silver in the mass, and the price of silver per oz.

11. A merchant has wines worth 7*s.*, 9*s.*, 11*s.* and 15*s.* a gallon respectively: how must he mix them to obtain a mixture worth 10*s.* a gallon, using equal parts of the first two kinds, and also equal parts of the last two kinds?

12. In what proportion must a grocer mix teas at 2*s.* 6*d.*, 3*s.* and 4*s.* 6*d.* per lb. to make a mixture worth 4*s.* per lb., using equal parts of the first two kinds?

13. A man has whisky worth 22*s.* a gallon, and another lot worth 18*s.* a gallon; equal quantities of these are mixed with water to obtain a mixture of 50 gallons worth 16*s.* a gallon; find how much water the mixture contains.

14. A grocer buys teas at 2*s.* 6*d.*, 3*s.* and 3*s.* 9*d.* per lb. respectively: how must he mix them so as to obtain a mixture worth 3*s.* 3*d.*, per lb., using the first two kinds in the proportion of 2 to 3?

15. A grocer wishes to mix teas at 2*s.*, 3*s.*, 3*s.* 6*d.* and 4*s.* per lb. respectively: how must he mix them (using the first two kinds in the proportion of 2 : 3, and the last two in the proportion of 3 : 4) so that by selling the mixture at 3*s.* 4*d.* per lb. $\frac{1}{20}$ of the receipts may be clear profit?

XLIII. AVERAGE VALUE.

226. The **average** or **mean value** of any number of quantities of the same kind is their sum divided by the number of them.

Example. Find the average age of four boys who are 10, 11, 13 and 14 years old respectively.

$$\text{Average age} = \frac{10+11+13+14}{4} \text{ years} = 12 \text{ years}.$$

EXAMPLES. 143.

Find the average of the numbers,

1. 1, 2, 3, 4, 5. **2.** 8, 10, 13, 15, 17, 20.

3. $3\frac{1}{2}$, $7\frac{3}{4}$, $8\frac{1}{4}$, $9\frac{1}{2}$, 10. **4.** 1·3, 7·6, 8·9, 3·1, ·8.

5. Find the average age of five boys who are 13, 15, 11, 9 and 8 years old respectively.

6. What was the average daily expenditure of a man in 1880, who spent R765 . 10 . 9 in the first half-year and R881 . 5 . 3 in the last?

7. The population of a town was 28750 in 1870 and 30000 in 1880; find the average annual increase between the two dates.

8. Of 20 men 12 gain £3. 7*s.* each and 8 men gain £2. 8*s.* each; what is the average gain per man?

9. Five men weighed respectively 8 st. 8 lb., 9 st. 4 lb, 10 st., 10 st. 10 lb. and 11 st. 6 lb.; what is the average weight per man?

10. If 20 chairs are bought at R5 each, and 15 at R4. 8*a*. each, and 15 more at R4 each, what is the average price of a chair?

11. A train travels 1 mile in the first 10 min., $1\frac{1}{2}$ miles in the next 10 min., 2 miles in the next, $1\frac{1}{2}$ miles in the next, and 1 mile in the next: what is the average speed of the train per hour?

12. The average weight of 6 men is 10 st.; two of them weigh 9 st. 7 lb. each; find the average weight of the others.

13. The average age of 8 men, 7 women and 1 boy is 45 years, that of the 8 men being 48 years and of the 7 women being 46; determine the age of the boy.

14. The average age of 5 children is 7 years, which is increased by 6 years when the age of the father is included; find the age of the father.

15. The average weight of 7 men is diminished by 3 lb. when one of them who weighs 10 stones is replaced by a fresh man; find the weight of the new man.

16. The average age of a class of 20 boys is 12 years; what will be the average age if 5 new boys receive admission in the class, whose average age is 7 years?

17. If the chairs in Question 10, are sold so as to gain $\frac{1}{4}$ of the cost price, what is the average selling price of a chair?

18. The average price of a chair, a table and a cot is R19; the average price of the table, the cot and a book-shelf is R22; if the price of the book-shelf be R16, find the price of the chair.

19. The average temperature for Monday, Tuesday, Wednesday and Thursday is 60°; the average for Tuesday, Wednesday, Thursday and Friday is 63°; if the ratio of the temperatures for Monday and Friday be 21 : 25, find these temperatures.

XLIV. PERCENTAGE.

227. The term **per centum** or **per cent.** means *for a hundred.*

Suppose that a trader who has a capital of R4000 gains R200; he gains R5 for every hundred of his capital. This is expressed by saying that *the trader's gain is* 5 *per cent.*

Note. The symbol % or the letters *p. c.* are used as an abbreviation for the words *per cent.*

Example 1. What fraction of a number does 5 p. c. of it denote?

5 p. c. of a number $=\frac{5}{100}$ of the number $=\frac{1}{20}$ of the number.

Example 2. How much is $6\frac{1}{4}$ p. c. of R320 ?

The percentage $=\frac{6\frac{1}{4}}{100}$ of R320 $=\frac{1}{16}$ of R320 $=$ R20.

EXAMPLES. 144.

What fractions are denoted by the following rates per cent. ?

1. $12\frac{1}{2}$. **2.** $33\frac{1}{3}$. **3.** $\frac{1}{4}$. **4.** $\frac{3}{8}$. **5.** 125.

Find the value of

6. 5 p. c. of R700. **7.** $7\frac{1}{2}$ p. c. of £140. **8.** $\frac{3}{4}$ p. c. of £20.

9. 35% of 3480 men. **10.** $\frac{1}{8}$% of a sq. ft. **11.** 8·5% of 50 cwt.

12. A man's income is R3000 a year ; if he spends $6\frac{1}{4}$ p. c. of it each month, how much does he save in a year ?

13. Five per cent. of the total population of a town are English men ; the rest are Hindus ; if the population of the town be 37820, what is the number of Hindus ?

14. A man's income in 1871 was £500 ; in 1872 it was increased by 20 p. c. ; what was his income in 1872 ?

15. Find the difference between $\frac{3}{4}$ of R70 and $\frac{3}{4}$ p. c. of R70.

16. A testator bequeathed by will $\frac{3}{8}$ of his estate to his son, 60 p. c. of the remainder to his daughter, and the remainder to his widow ; the son got £75 more than the daughter. How much did the widow receive ?

Example 3. What *rate per cent.* does the fraction $\frac{3}{8}$ denote ?

The fraction, $\frac{3}{8}=\frac{3\times 100}{8\times 100}=\frac{\frac{300}{8}}{100}=\frac{37\frac{1}{2}}{100}$;

$\therefore$ rate per cent. $=37\frac{1}{2}$.

Example 4. What per cent. of R40 is R3 ?

The fraction $=\frac{3}{40}=\frac{300}{40\times 100}=\frac{\frac{300}{40}}{100}=\frac{7\frac{1}{2}}{100}$;

$\therefore$ rate per cent. $=7\frac{1}{2}$.

EXAMPLES. 145.

What rates per cent. do the following fractions denote ?

1. $\frac{1}{4}$. **2.** $\frac{1}{3}$. **3.** $\frac{1}{80}$. **4.** $\frac{2}{3}$. **5.** $\frac{9}{4}$.

6. $\frac{7}{80}$. **7.** $\frac{5}{8}$. **8.** $\frac{13}{16}$. **9.** $\frac{7}{16}$. **10.** $\frac{43}{50}$.

What per cent. of

11. R26 is R13 ? **12.** R40 is R8 ? **13.** £3 is 12*s.* ?

14. $\cdot 25$ is $\frac{1}{7}$? **15.** $\frac{1}{3}$ is $\cdot 7$? **16.** $\cdot\dot{6}$ is $\cdot\frac{3}{3}$?

17. Of 3120 men in a town, 420 died; what per cent. survived?

18. Out of a debt of R2500, R1900 is paid; what per cent. of the debt still remains unpaid?

19. The number of boys in a school in January was 320; in February it increased to 360. Find the increase per cent.

20. A mass of gunpowder is made with 2 lb. $5\frac{1}{3}$ oz. of nitre, 5 oz of sulphur and $7\frac{1}{3}$ oz. of charcoal; find the percentage composition of the powder.

21 Standard gold contains 11 parts pure gold out of 12; what per cent is dross?

Example 5 Of what sum of money is R30, 5 p. c.?

5 p. c. of the sum = R30,

or $\frac{5}{100}$ of the sum = R30;

$\therefore$ the sum = R30 $\times \frac{100}{5}$ = R600.

EXAMPLES. 146.

Of what number is

1. 22, 10 p. c.? **2.** 57, $4\frac{3}{4}$ p. c.? **3** 30, 120 p. c.?

4. 81, $\frac{3}{4}$ p. c.? **5.** $2\frac{1}{2}$, $2\frac{1}{2}$ p. c.? **6.** $3\frac{1}{2}$, $\cdot 27$ p. c.?

7. A man spends R3250 a year, which is $66\frac{2}{3}$ p. c. of his yearly income; find his income.

8. A man spends 60 p. c. of his income and saves R2000; what is his income?

9. The population of a town increased 7 p. c. from 1880 to 1883, and its population in the latter year was 13910; what was its population in 1880?

10. If a tax of 10 p. c. on the income of a man yields R300, how much will an income-tax of 5 pies in the R produce?

MISCELLANEOUS EXAMPLES. 147.

1. The price of a bottle of red ink is 20 p. c. more than that of a bottle of black ink. If a bottle of red ink costs 12 annas, how much will a bottle of black ink cost?

2. A trader in his first year gains 8 p. c. of his capital, but in the second year loses 10 p. c. of what he had at the end of the first year, and his capital is R224 less than at first; find his original capital.

3. A trader's capital increased 10 p. c. every year; at the end of 3 years it was R6050; what was his capital at first?

4. In a mixed school 25 per cent. of the scholars are infants under 7, and the number of girls above 7 is $\frac{2}{7}$ of the boys above 7, and amounts to 36; find the number of children in the school.

5. A man spends 5 p. c. of his income in insuring life, and this part is exempted from income-tax; his income-tax which is laid at 4 pies in the rupee, amounts to R30. 5*a*.; find his gross income.

6. Three casks contain equal quantities of wine; a mixture is formed by taking 25 p. c. of the first cask, 35 p. c. of the second and 45 p. c. of the third; what per cent. of the whole quantity is taken?

7. Two mixed schools have 90 and 120 children respectively; in the first 60 p. c. and in the second 50 p. c. of the children are boys; what per cent. of the children in the two schools are boys?

8. In a town the numbers of male and female inhabitants are 3450 and 3020 respectively; the decrease in the former is 10 p. c., while the increase in the latter is 5 p. c. Find the increase or decrease per cent. of the total population.

9. In a mixture of coffee and chicory the coffee is 40 per cent; to 500 lb. of the mixture a quantity of chicory is added, and then the coffee is $36\frac{4}{11}$ p. c. How many pounds of chicory are added?

10. If *A*'s income be 10 per cent. more than *B*'s, how much per cent. is *B*'s income less than *A*'s?

11. *A* sells his goods 10 per cent. cheaper than *B*, and 10 per cent. dearer than *C*; how much per cent. are *C*'s rates lower than *B*'s?

12. The price of sugar being raised 10 p. c, by how much per cent. must a man reduce his consumption of that article so as not to increase his expenditure?

XLV. COMMISSION, BROKERAGE, PREMIUM.

228. **Commission** is the sum of money paid to an agent for buying or selling goods or property of any kind. It is usually *a percentage* upon the value of goods bought or sold.

The agent is sometimes called a **broker**, especially when he buys or sells Government Promissory Notes, Shares of Companies, etc, and the commission, **brokerage.**

Premium is the sum of money paid to an *Insurance Company* which, in consideration thereof, undertakes to make good a loss incurred through fire or shipwreck, or to pay a certain sum of money after a man's death to his relatives. The instrument containing the contract is called the **Policy of Insurance**; and the stamp duty on the policy is called the **Policy duty.**

Premium is usually *a percentage* upon the sum of money which the insurer or his relatives are to receive.

Commission, Brokerage and Premium are therefore names given to a percentage in particular cases.

Example 1. An agent buys goods worth R750, and receives a commission of $2\frac{1}{2}$ per cent.; how much does he get?

$$\text{Commission} = \frac{2\frac{1}{2}}{100} \text{ of R}750 = \text{R}\frac{75}{4} = \text{R}18.\ 12a.$$

Example 2. A cargo, valued at £760, is to be insured at 5 p. c. premium; what sum must be insured that, in case of loss, the value of cargo and the premium paid may be recovered?

If every £95 (£100 − £5) be insured for £100, then in case of loss both the value of goods and premium paid will be recovered.

Now since £95 must be insured for £100,

£1 .... £$\frac{100}{95}$,

£760.......................... £$\frac{760 \times 100}{95}$,

£800. *Ans.*

EXAMPLES. 148.

1. A broker purchases goods worth R5000; what is his commission at $3\frac{1}{2}$ per cent.?

2. What is the cost of insuring cargo valued at £7000, the premium being $3\frac{1}{2}$ per cent?

3. A commission agent sells 720 bales of jute at R7 per bale; what commission does he receive at $1\frac{1}{2}$ per cent.?

4. An agent buys a house for R6750, and receives commission at R3. 12*a.* per cent.; what has his employer to pay altogether?

5. A broker received $\frac{1}{8}$ p. c. for buying Government Promissory Notes. His brokerage amounted to R35; what was the value of the Promissory Notes bought?

6. A ship is insured for $\frac{2}{3}$ of its value at $1\frac{1}{4}$ p. c. and the premium is £20; what is the ship worth?

7. The premium on a policy of insurance at 4 p. c. is R120; find the amount of the policy.

8. How much must be paid to insure a cargo worth £5720, the premium being 25*s.*, policy duty 1*s.* 6*d.*, and brokerage 9*s.*, per £100 respectively?

9. For what sum must a merchant insure a cargo worth R9760 at $2\frac{3}{8}$ p. c. so that in case of loss both the cargo and premium may be recovered?

10. Goods worth £7740 are insured at $3\frac{1}{4}$ per cent., so that in case of loss both the value of goods and premium may be recovered ; find the amount of premium paid.

11. Cargo worth £5000 is to be insured, so that in case of loss its value and all the expenses connected with its insurance may be recovered. The premium is $2\frac{1}{10}$ per cent., policy duty $\frac{3}{40}$ per cent. and brokerage $\frac{1}{4}$ per cent. ; for what sum must the cargo be insured and what is the amount of the whole expense paid on insurance ?

XLVI. PROFIT AND LOSS.

229. Under this head we estimate a profit or a loss, not absolutely, but in relation to the cost price, that is, as so much per cent. on the *cost price*.

Example 1. If chairs are bought at R5 each, and sold at R5. 9*a.* each, what is the gain per cent. ?

The gain is 9*a.* on R5 or 80*a.* ; and we have to find what per cent. of 80*a.* is 9*a.*

Now, the fraction $=\frac{9}{80}=\frac{900}{80\times100}=\frac{\frac{900}{80}}{100}=\frac{11\frac{1}{4}}{100}$;

$\therefore$ the gain is $11\frac{1}{4}$ per cent.

Example 2. A horse is bought for R80, and is sold at a profit of 25 p. c. ; what does the profit amount to, and for how much is the horse sold ?

Profit $=$ 25 p. c. of R80 $=\frac{25}{100}$ of R80 $=$ R20.

$\therefore$ The horse is sold for R80 + R20, or R100.

Example 3. Some goods are bought for R90 ; for how much must they be sold so as to gain 10 per cent. ?

The selling price $=$ 110 p. c. of cost price

$=\frac{110}{100}$ of R90 $=$ R99.

Example 4. By selling sugar at R12 per md. I gain 20 p. c. ; at what price per md. did I buy it ?

120 p. c. of the cost price $=$ selling price,

or $\frac{120}{100}$ of the cost price $=$ R12 ;

$\therefore$ the cost price $=$ R12 $\times\frac{100}{120}=$ R10.

Example 5. If 10 p. c. be lost by selling an article for R72, for how much should it have been sold so as to gain 5 per cent. ?

90 p. c. of the cost price $=$ R72,

$\therefore$ 15 .... $=$ R12,

$\therefore$ 105 .... $=$ R84. *Ans.*

Example 6. By selling a house for £69 there is a loss of 8 p.c.; what would be the loss or gain per cent. by selling it for £78?

$$\begin{aligned} £69 &= 92 && \text{p. c. of the cost price,} \\ \therefore\ £1 &= \tfrac{92}{69} && \text{......................} \\ \therefore\ £78 &= \tfrac{92 \times 78}{69} && \text{......................} \\ &= 104 && \text{......................} \end{aligned}$$

∴ There would be a gain of 4 per cent.

EXAMPLES. 149.

1. I sell for R20 that for which I gave R16; what is my gain per cent.?

2. At what rate per cent. is the loss on selling for £11 . 9 . 8½ what cost £15 . 6 . 3?

3. I sell 20 articles for the same money as I paid for 25; what do I gain per cent. on my outlay?

4. If the selling price of ¾ of a number of toys be equal to the cost price of the whole, find the profit per cent.

5. 70 gallons of wine are bought for £50, and 9 gallons are lost by leakage; the remainder is sold at 1*s.* 10½*d.* a pint; find the gain or loss per cent. on the outlay.

6. Certain articles are bought at £12. 15*s.* for 100, and are sold at 2½ guineas for a dozen; find the gain or loss per cent.

7. A person by selling 48 yards of cloth gained the cost of 16 yards; find the gain per cent.

8. 320 maunds of rice were bought at R5 per maund, and sold at a loss of 5 p. c.; find the total loss and the selling price per seer.

9. A merchant buys certain goods at £6. 19. 3 per cwt. and pays 15*s.* per ton for expenses; at what price per lb. must he sell them so as to gain 15 p. c. on his total outlay?

10. If oranges are bought at the rate of 15 for a rupee, how many must be sold for a rupee so as to gain 25 p. c.?

11. The cost price of a book is 7*s.* 6*d.*; if the expenses of sale be 5 p. c. upon this, and the profit 20 p. c., what would be the retail price?

12. 24 gallons of ale are bought at 2*s.* a gallon and 30 gallons of porter at 1*s.* a gallon, and they are mixed together. If 13 gallons of the mixture be lost by leakage, and 20 gallons sold at 2*s.* 3*d.* a gallon, at what price per gallon must the remainder be sold to gain 20 p. c. on the whole outlay?

13. A man having bought a quantity of tea for R75, sells ⅓ of it at a loss of 4 p. c.; by what rate per cent. must he raise that

selling price, in order that by selling the rest at the increased price he may gain 4 p. c. on his outlay ?

14. I bought note paper at the rate of 8 annas for 5 quires, and sold it so as to gain as much on the cost of 32 quires as 8 quires were sold for ; at what price did I sell the paper per quire ?

15. A horse is sold for R440, at a loss of 12 p. c. ; how much did it cost ?

16. A quantity of sugar is sold at *6a. 9p.* per seer ; the gain is $12\frac{1}{2}$ p. c. and the total gain is R15. What is the quantity of sugar sold ?

17. If oranges are sold at the rate of 11 for the rupee and the gain is $8\frac{1}{3}$ p. c., at what rate were they purchased ?

18. A bankrupt's stock was sold for R5205 at a loss of 17 per cent. on the cost price ; had the stock been sold in the ordinary course of trade it would have realized a profit of 20 per cent. How much was it sold under the trade price ?

19. A horse was sold for R240 at a loss of $5\frac{1}{5}$ p c. ; for what should it have been sold to gain 26 p. c. ?

20. By selling tea at *3s.* per lb. a grocer gains only 5 p. c. ; by how much must he raise the price so as to gain 15 p. c. ?

21. If by selling 7 mangoes for R1. 2. $4\frac{1}{2}$ there be a profit of $16\frac{2}{3}$ per cent., at what price per dozen must they be sold to gain 20 per cent. ?

22. If a man lose 4 p. c. by selling oranges at the rate of 12 a rupee, how many a rupee must he sell them so as to gain 44 p. c. ?

23. If by selling goods for R141 there be a loss of 6 p. c. ; what will be the loss or gain per cent by selling them for R159 ?

24. Goods were sold for R37. *8a.* with a gain of $12\frac{1}{2}$ p c. ; what would have been gained or lost by selling them for R33. *8a.* ?

25. Tea which cost R60 per md. is retailed at R2. *8a* per seer, and there is a waste of 10 p. c ; what is the rate of profit per cent. ?

26. Sulphuric acid worth *3d.* per lb. absorbs moisture and becomes $2\frac{1}{2}$ p c. heavier ; what is it then worth per lb. ?

27. A merchant sells tea to a tradesman at a profit of 40 p. c , but the latter becoming bankrupt pays only *12s.* in the £ ; how much per cent. does the merchant gain or lose on his outlay ?

28. A tradesman's prices are 30 p. c. above the cost price ; if he allows his customers 10 p. c. on his bill, what profit does he make ?

29. How much per cent. must a tradesman add on to the cost price of his goods, that he may make 20 p c. profit after allowing his customers a reduction of 5 p. c. on his bill ?

30. The price of flour being raised 20 per cent., by how much

per cent. must a man reduce his consumption of that article so as not to increase his expenditure?

31. An article when sold at a gain of 5 p. c. yields ₨15 more than when sold at a loss of 5 p. c.; what was its prime cost?

32. A man sells an article at a loss of 10 p. c.; if he had received ₨5 more, he would have gained $12\frac{1}{2}$ p. c. What did the article cost him?

33. A piece of cloth is sold for ₨40. 10*a*. at a profit of 30 p. c. If it had been sold at ₨1. 12*a*. per yard, the profit would have been ₨12. 8*a*.; how many yards are there in the piece?

34. A man embarks his capital in three successive ventures. In the first he clears 80 p. c., and in each of the others he loses 15 p. c.; what per cent. does he gain or lose on his original outlay?

35. A boy buys a number of apples at 6 for 4*a*. and a third of the number at 4 for 2*a*.; at what rate must he sell them to gain 20 p. c. on his outlay? Supposing his total profit to be ₨4, how many did he buy?

36. How must a grocer mix teas at 3*s*. a lb. and 3*s*. 6*d*. a lb., so that by selling the mixture at 3*s*. 8*d*. a lb. he may gain 10 p. c.?

37. I must sell my stock of sugar at 3*a*. 6*p*. per lb. to gain $33\frac{1}{3}$ per cent.; by mixing it with an inferior sugar in the proportion of 4 to 1 I gain $33\frac{1}{3}$ p. c. by selling at ₨1. 9*a*. 6*p*. for $7\frac{1}{2}$ lb. Find the cost of the inferior sugar per lb.

38. A grocer proposes to sell his tea at 10 per cent. profit, but adulterates it by adding $\frac{1}{5}$ of its weight of an inferior tea which costs him $\frac{2}{3}$ of the price of the better; what profit per cent. does he make? Also in what proportion must he mix the two kinds so as to gain 20 per cent.?

39. A merchant buys 1575 cubits of cloth. He sells $\frac{1}{3}$ of it at a gain of 6 p. c., $\frac{1}{5}$ at a gain of 8 p. c., $\frac{1}{7}$ at a gain of 12 p. c. and the rest at a loss of 3 p. c. If he had sold the whole at a gain of 5 p. c. he would have received ₨120. 12*a*. more than he did. What was the prime cost of a yard?

40. How must wine at 20*s*. a gallon and brandy at 45*s*. a gallon be mixed, so that by selling the mixture at 35*s*. a gallon there may be a gain of 15 p. c. on the price of the wine and 20 p. c. on the price of the brandy?

41. A mixture of two kinds of wine, at 20*s*. and 25*s*. a gallon, is sold at a gain of 10 p. c. If the two kinds had been sold separately at a gain of 15 p. c. and 8 p. c. respectively, the total profit would have been the same. In what proportion were the two kinds of wine mixed together?

42. A tradesman by means of a false balance, defrauds to the extent of 10 p. c. in buying goods, and also defrauds in selling. What per cent. does he gain on his outlay by his dishonesty?

43. A man sells a house at a loss, for ₨400; had he sold it for ₨500 his gain would have been $\frac{3}{5}$ of his former loss; find the cost price of the house.

44. A merchant has goods worth £300; he sells one-third of them so as to lose 10 p. c. By how much per cent. should he raise that selling price in order to gain 10 p. c. on the whole?

XLVII. SIMPLE INTEREST.

230. **Interest** is money paid for the use of money lent. The money lent is called the **Principal**. The **Amount** is the sum of the principal and interest at the end of any time. The **rate of interest** is the money paid for the use of a certain sum for a certain time. Thus, if I borrow a sum of money on the condition that for the use of every rupee in the loan for a month I shall pay an interest of $\frac{1}{2}$ anna, I am said to borrow *at the rate of* $\frac{1}{2}$ anna per rupee per month. Again, If I borrow on the condition that for the use of every ₨100 in the loan for one year I shall pay an interest of ₨5, I am said to borrow *at the rate of* 5 per cent. per annum.

Note. *Per annum* means *for a year.*

231. When interest is calculated simply on the original principal it is called **Simple** Interest.

Note 1. The term interest is generally used in the sense of *simple* interest.

Example 1. Find the simple interest on ₨24 for 5 months at $\frac{1}{2}$ anna per rupee per month.

Interest on ₨1 for 1 month $= \frac{1}{2}a. =$ ₨$\frac{1}{32}$,

$\therefore$ .... ₨24 for 1 month $=$ ₨$\frac{1}{32} \times 24$,

$\therefore$ .... ₨24 for 5 months $=$ ₨$\frac{1}{32} \times 24 \times 5$.

$=$ ₨3. 12*a*.

Hence, to find the interest we multiply the principal by 5 and by $\frac{1}{32}$, that is, we multiply it by $\frac{5}{32}$. The work in practice should stand thus:

```
          ₨.
          24
           5
    32 ) 120 ( ₨3. 12a.   Ans.
          96
          --
          24
          16
          --
         384 ( 12
         32
          --
          64
          64
          --
```

EXAMPLES. 150.

Find the simple interest on

1. R58 for 14 months at 6*p*. per rupee per month.
2. R76 for 9 months at 2 pice per rupee per month.
3. R240 for 1 year at 3*p*. per rupee per month.
4. R375 for 15 months at $\frac{3}{4}$ anna per rupee per month.
5. R29 for 3 years 3 months, at 2*p*. per rupee per month.
6. R720 for 18 months at 4*p*. per rupee per month.

Example 2. Find the simple interest on R728 for 5 years at 4 per cent. per annum.

Interest on R100 for 1 year $=$ R4,

$\therefore$ .... R1 for 1 year $=$ R$\frac{4}{100}$,

$\therefore$ .... R728 for 1 year $=$ R$\frac{728\times 4}{100}$,

$\therefore$ .... R728 for 5 years $=$ R$\frac{728\times 4\times 5}{100}$

$=$ R145. 9*a*. $7\frac{1}{5}$*p*.

Hence we deduce the following rule :

Multiply the principal by the rate per cent. and by the number of years, and divide the product by 100.

The work should stand thus :

We divide R14560 by 100 by cutting off the two figures on the right ; thus the quotient is R145 and R60 is the remainder : this remainder is equal to 960*a*. ; this divided by 100 gives 9*a*. as quotient and 60*a*. as remainder : this remainder is equal to 720*p*. ; this divided by 100 gives 7·2*p*. as quotient.

```
            R.
           728
             4
          ----
          2912
             5
         -----
100 ) R145.60
            16
         -----
       a. 9.60
            12
         -----
       p. 7.20
```

$\therefore$ Interest $=$ R145. 9*a*. 7·2*p*.

$=$ R145. 9*a*. $7\frac{1}{5}$*p*.

Note 2. The amount may be obtained by adding the interest to the principal. Thus the amount in the above example,

$=$ R728 $+$ R145. 9*a*. $7\frac{1}{5}$*p*.

$=$ R873. 9*a*. $7\frac{1}{5}$*p*.

If the amount only is wanted we may also proceed thus :

Interest on R100 for 5 years at 4 p. c. $=$ R20.

$\therefore$ The amount of R100 in 5 years $=$ R120,

$\therefore$ .... R1 .... $=$ R$\frac{120}{100}$,

$\therefore$ .... R728 .... $=$ R$\frac{728\times 120}{100}$

$=$ R873. 9*a*. $7\frac{1}{5}$*p*.

EXAMPLES. 151.

N. B. The rate per cent. is understood to be *per annum* unless otherwise stated.

Find the simple interest on

1. R200 for 3 yr. at 4 p. c. 2. £300 for 4 yr. at 5 p. c.
3. R750 for 7 yr. at 6 p. c. 4. £128 for 15 yr. at 3 p. c.
5. R450 for 11 yr. at $4\frac{1}{2}$ p. c. 6. £800 for $3\frac{1}{2}$ yr. at 4 p. c.

Find the simple interest and the amount of

7. R495. 4*a*. for $2\frac{3}{4}$ yr. at 3%. 8. £325. 5*s*. for 4 yr. at $2\frac{1}{2}$%.
9. R225. 11*a*. 9*p*. for 4 years at 1 per cent. per month.

Find the amount only of

10. R250 for 2 yr. at 7 p. c. 11. £304 for 5 yr. at $4\frac{1}{2}$ p. c.
12. R335 for $3\frac{1}{2}$ years at $\frac{3}{4}$ per cent. per month.
13. R720. 8*s*. 6*p*. for $2\frac{1}{4}$ years at $2\frac{2}{3}$ per cent.
14. £329. 9*s*. $4\frac{1}{2}$*d*. for $7\frac{1}{8}$ years at $3\frac{1}{3}$ per cent.
15. £220 for 7 months at $4\frac{3}{4}$ per cent.

Note 3. When the rate per cent. and the number of years (or either of them) are fractional numbers, it is convenient first to multiply these two, and then multiply the principal by the product.

Example 3. Find the simple interest on R345. 10*a*. 3p. for 2 years 6 months at $5\frac{1}{4}$ per cent.

Now, 2 years 6 months $= 2\frac{1}{2}$ years ;

and $2\frac{1}{2} \times 5\frac{1}{4} = \frac{5}{2} \times \frac{21}{4} = \frac{5 \times 7 \times 3}{8}$.

$$
\begin{array}{rrrrr}
 & \text{R.} & a. & p. & \\
 & 345 & 10 & 3 & \\
 & & & 5 & \\
\hline
 & 1728 & 3 & 3 & \\
 & & & 7 & \\
\hline
 & 12097 & 6 & 9 & \\
 & & & 3 & \\
\hline
8 \,) & 36293 & 4 & 3 & \\
\hline
 & \text{R}45.36 & 8 & 6\frac{3}{8} & \\
 & 16 & & & \\
\hline
a. & 5.84 & & & \\
 & 12 & & & \\
\hline
p. & 10.14\frac{3}{8} & & &
\end{array}
$$

See Example 2.

The interest $=$ R45. 5*a*. $10{\cdot}14\frac{3}{8}$*p*.
$=$ R45. 5*a*. $10\frac{23}{160}$*p*.

EXAMPLES. 152.

N. B. When the time is given in *months* and *days*, 12 months are reckoned to the year, and 30 days to the month.

Find the simple interest on

1. R375 for $3\frac{1}{3}$ years at $2\frac{2}{3}$ per cent.
2. £450 for $6\frac{2}{3}$ years at $3\frac{1}{8}$ per cent.
3. £875 for 3 years 4 months 15 days at $5\frac{1}{3}$ per cent.

Find, to the nearest pie, the simple interest on

4. R309. 10*a*. 3*p*. for 5 months 10 days at $4\frac{1}{6}$ per cent.
5. R21. 15*a*. 9*p*. for 2 years 9 months at $3\frac{1}{3}$ per cent.
6. R101. 13*a*. for 1 year 7 months 6 days at $\frac{1}{6}$ per cent. per month.

Note 4. When interest has to be calculated from one day of the year to another, it is customary to include *one only* of the days named.

Example 4. Find the interest on £320 from January 4th to May 30th, at 3 per cent.

Number of days $= 27 + 28 + 31 + 30 + 30 = 146$;

146 days $= \frac{146}{365}$ of a year $= \frac{2}{5}$ yr.; and $3 \times \frac{2}{5} = \frac{6}{5}$.

$$\begin{array}{r}
\text{£.} \\
320 \\
6 \\
\hline
5\,)\;1920 \\
\text{£}3.84 \\
20 \\
\hline
s.\ 16.80 \\
12 \\
\hline
d.\ 9.60
\end{array}$$

$\therefore$ the interest $=$ £3. 16*s*. $9\frac{3}{5}$*d*.

Note 5. It should be noted that factors of 365 are 5 and 73.

EXAMPLES. 153.

N. B. When the time is given in *days* or *years and days*, the year is taken to consist of 365 days.

Find the simple interest on

1. £400 from April 4th to June 16th at 3 p. c.
2. [illegible] from Feb. 23rd to Sep. 30th at $4\frac{1}{2}$ p. c.

3. ₹321. 8*a.* from Dec. 10th, 1887, to May 4th, 1888, at $3\frac{3}{4}$ p. c.
4. £847. 15*s.* from Jan. 1st to April 1st at $2\frac{1}{2}$ p. c.
5. ₹349. 8*a.* 9*p.* from June 1st to Oct. 4th at $5\frac{3}{4}$ p. c.
6. ₹309. 12*a.* for 1 year 73 days at $2\frac{2}{3}$ p. c.

232 Inverse questions on Simple Interest.

Example 1. At *what rate* per cent. will ₹425 amount to ₹476 in 3 years?

Interest on ₹425 for 3 years = ₹51, (*i. e.*, ₹476 − ₹425),

∴ .... ₹1 for 3 years = ₹$\frac{51}{425}$,

∴ .... ₹1 for 1 year = ₹$\frac{51}{425 \times 3}$,

∴ .... ₹100 for 1 year = ₹$\frac{51 \times 100}{425 \times 3}$

= ₹4;

∴ the rate per cent. = 4.

EXAMPLES. 154.

At what rate per cent. will

1. ₹300 amount to ₹337. 8*a.* in 5 years?
2. ₹825 amount to ₹905. 7*a.* in 3 years?
3. £142. 10*s.* amount to £163. 13*s.* $11\frac{1}{4}$*d.* in $4\frac{1}{2}$ years?
4. the interest on ₹22214. 4*a.* amount to ₹462. 12*a.* 9*p.* in 7 months 10 days?
5. a given sum of money double itself in 20 years?
6. the interest on any sum of money be $\frac{2}{3}$ths of the amount in 20 years?
7. the interest on £1368. 15*s.* become £14. 4*s.* $7\frac{1}{2}$*d.* from July 5th to Nov. 20th?
8. At what rate per rupee per month will ₹250 amount to ₹312. 8*a.* in 8 months?

Example 2. In *how many years* will £300 amount to £405 at 5 per cent.?

Interest on £300 for 1 year = £$\frac{300 \times 5}{100}$ = £15; and interest on £300 for the required number of years = £405 − £300 = £105.

∴ the required number of years = $\frac{£105}{£15} = 7$.

EXAMPLES. 155.

In what time will

1. ₹475 amount to ₹532 at 4 p. c. ?

2. ₹266 . 10 . 8 amount to ₹293 . 5 . 4 at 3 p. c. ?

3. £1451 . 6 . 8 amount to £1667 . 4 . $4\frac{3}{8}$ at $4\frac{1}{4}$ p. c. ?

4. In how many years and months will the interest on £3125 amount to £556 . 12 . $9\frac{3}{4}$ at $3\frac{3}{4}$ p. c. ?

5. In how many years, months and days will ₹425 amount to ₹474 . 3 . 8 at 5 p. c. ?

6. In how many days will the interest on £121 . 13 . 4 amount to £2 . 0 . 5 at $6\frac{1}{4}$ p. c. ?

7. In how many years will a sum of money treble itself at $3\frac{1}{8}$ p.c.?

8. In what time will the interest on any sum of money at $6\frac{1}{4}$ p. c. be ·1875 of the principal ?

9. In what time will the interest on any sum of money at 5 p. c. be $\frac{1}{8}$ of the amount ?

10. On Feb. 1st, 1818, a person borrowed £400 at $6\frac{1}{4}$ p c., promising to return it as soon as the interest amounted to £5 : on what date did the loan expire ?

11. In how many months will ₹3200 amount to ₹4000 at 3 pies per rupee per month ?

Example 3. *What principal* will amount to ₹1000 in 10 years at $2\frac{1}{2}$ per cent. ?

Interest on ₹100 for 10 years at $2\frac{1}{2}$ p. c. = ₹25 ;

∴ ₹100 amounts to ₹125 in 10 yr. at $2\frac{1}{2}$ p. c.

Of the amount ₹125 the principal = ₹100,

∴ .... ₹1 .... = ₹$\frac{100}{125}$,

∴ .... ₹1000 .... = ₹$\frac{100 \times 1000}{125}$

= ₹800. *Ans.*

EXAMPLES. 156.

What principal will amount to

1. ₹909 in 5 years at 4 per cent. ?

2. ₹4546 . 10 . 8 in $1\frac{1}{2}$ years at $5\frac{1}{4}$ per cent. ?

3. £190. 15s. in 3 years at 4 per cent. ?

4. £1153 . 9 . $4\frac{1}{2}$ in 3 years 7 months at $2\frac{3}{4}$ per cent. ?

5. ₹459 . 2 . 8 in 2 years 4 months and 12 days at $6\frac{1}{4}$ per cent.

6. ₨737. 8*a*. in 100 days at $3\frac{3}{4}$ per cent.?

7. ₨809 at $5\frac{5}{8}$ per cent. from April 20th to July 2nd?

8. ₨255. 7*a*. 6*p*. in $1\frac{1}{4}$ years at 3 pice per rupee per month?

What principal will produce

9. ₨37. 8*a*. 8*p*. interest in 4 years 3 months at $3\frac{1}{3}$ per cent?

10. £23 . 7 . $1\frac{1}{2}$ interest in 15 years at $4\frac{5}{8}$ per cent.?

11. Find, to the nearest pie, the sum that must be invested at $3\frac{3}{4}$ per cent. for 13 years to amount to ₨1000.

12. Find, to the nearest penny, the principal whose interest amounts to £100 in 2 years 5 months and 10 days at 4 per cent.?

MISCELLANEOUS EXAMPLES. 137.

1. The interest on a sum of money at the end of 6 years is $\frac{3}{8}$ths of the sum itself; what rate per cent. was charged?

2. A money lender lent a sum of money for 3 years 7 months at $1\frac{1}{2}$ pice per rupee per month. At the end of the time he received ₨1003. 14. 6: what was the sum lent?

3. A sum of money increases by $\frac{1}{12}$ of itself every year, and in 7 years it amounts to ₨902. 8*a*.: find the sum.

4. £275 increases by $\frac{1}{10}$ of itself per year: how long will it take to amount to £357. 10*s*.?

5. A sum of money amounts in 6 years at 5 per cent simple interest to ₨442; in how many years will it amount to ₨510?

6. ₨500 is borrowed at the beginning of the year at a certain rate of interest, and after 7 months ₨350 more is borrowed at half the previous rate. At the end of the year the interest on both loans is ₨34. 6*a*. What is the rate of interest at which the first sum was borrowed?

7. What sum of money laid out at $3\frac{3}{4}$ per cent. will give ₨1 interest a day?

8. The principal and interest for 5 years are together ₨550, and the interest is $\frac{3}{8}$ of the principal: find the principal and the rate per cent. per annum.

9. The principal and interest for a certain time at $3\frac{1}{3}$ per cent. are together £450, and the interest is $\frac{1}{8}$ of the principal: find the time.

10. What sum lent out at 5 per cent. will produce in $4\frac{1}{2}$ years the same amount of interest as ₨500, lent out at 6 per cent., will produce in 4 years?

11. If an investment of £75 becomes £78. 15*s*. in 8 months,

what sum invested at the same rate of interest will become £201. 17s. 6d. in 10 months?

12. *A* bequeaths to *B* a certain sum of money, which after paying a legacy duty of 10 per cent. yields an income of £810 when placed at interest of 3 per cent. Find the amount bequeathed.

13. A person who pays 4p. in the ₨ income-tax finds that a fall of interest from 4 to $3\frac{3}{4}$ per cent. diminishes his net yearly income by ₨47. What is his capital?

14. A sum of money doubles itself in 20 years; in how many years would it treble itself?

XLVIII. COMPOUND INTEREST.

233. When *interest*, as soon as it becomes due, is added to the principal, and interest charged upon the whole, it is called **Compound** interest.

Example. Find the compound interest on ₨321. 8a. for 3 years at $2\frac{1}{2}$ per cent. per annum.

Now, ₨321. 8a. = ₨321·5, and $2\frac{1}{2}$ p. c. = 2·5 p. c.

Division by 100 is effected by moving the decimal point two places to the left.

```
                ₨.
              321·5
                2·5
              16075
              6430
             8·0375 = int. for 1st year.
           321·5
           329·5375 = amt. in 1 year.
                2·5
           16476875
           6590750
           8·23884375 = int. for 2nd year.
         329·5375
         337·7759375 = amt. in 2 years.
                 2·5
         16888796875
         6755518750
         8·4443984375 = int. for 3rd year.
       337·7759375
       346·2203359375 = amt. in 3 years.
       321·5          = principal.
        24·7203359375 = Total Interest which
                      = ₨24. 11a. 6·3015p. Ans.
```

Note 1. The compound interest might also be obtained by adding together the interest for the 1st year, interest for the 2nd year and interest for the 3rd year. If the interest for $2\frac{3}{4}$ years were required, it would be obtained by adding together the interest for the 1st year, interest for the 2nd year and $\frac{3}{4}$ of the interest for the 3rd year.

Note 2. If the interest is payable *half-yearly*, the result may be obtained by finding the interest for double the number of years at half the rate per cent.

EXAMPLES. 158.

N. B. The interest is understood to be payable *yearly* unless otherwise stated.

Find, to the nearest pie, the compound interest on

1. R400 for 2 yr. at 5 p. c. **2.** R520 for 2 yr. at 4 p. c.

3. R500 for $2\frac{1}{2}$ yr. at 3 p. c. **4.** R1000 for 3 yr. at $4\frac{1}{2}$ p. c.

Find, to the nearest penny, the amount, at compound interest, of

5. £650 in 3 yr. at 4 p. c. **6.** £320. 8*s*. in 2 yr. at $3\frac{1}{2}$ p. c.

7. £600 in $2\frac{1}{4}$ yr at 3 p. c. **8.** £250 in $2\frac{3}{4}$ yr. at $1\frac{1}{2}$ p. c.

9. Find the compound interest on R350 for 1 yr. at 4 p. c. per annum, the interest being payable half-yearly.

10. Find the compound interest on £200 for $1\frac{1}{2}$ yr. at 10 p. c. per annum, the interest being payable quarterly.

234. The following method of finding the amount at compound interest is often useful.

Example 1. Find the amount, at compound interest, of R5000 in 3 years at 4 p. c.

Amount of R100 at the end of 1 yr. = R104;

∴ ....R1 .... = R$\frac{104}{100}$;

∴ ....any sum........................ = $\frac{104}{100}$ of the sum.

Also, amount of any sum at the end of 2 yr. = $\frac{104}{100}$ of the amount at the end of 1st yr.

= $\frac{104}{100}$ of $\frac{104}{100}$ of that sum

= $(\frac{104}{100})^2$ of that sum.

Similarly, amount in 3 years = $(\frac{104}{100})^3$ of that sum; and so on.

Hence, to find the amount of R5000 in 3 years, we have to multiply R5000 by $(104)^3$, and divide the product by $(100)^3$.

Process :

$$
\begin{array}{r}
\text{R}\ 5000 \\
104 \\
\hline
520000 \\
104 \\
\hline
208 \\
52 \\
\hline
54080000 \\
104 \\
\hline
21632 \\
5408 \\
\hline
\text{R}5624{\cdot}320000
\end{array}
= \text{amt. in 3 years, which}
$$

$= \text{R}5624.\ 5a.\ 1{\cdot}41p.$ *Ans.*

Division by $(100)^3$ is effected by marking off 6 decimal places in the final product.

Example 2. Find the amount of R400 for $2\frac{1}{2}$ years at 6 per cent. compound interest.

$$\text{Amount} = \text{R}400 \times \tfrac{106}{100} \times \tfrac{106}{100} \times \tfrac{103}{100} = \text{etc.}$$

Example 3. What principal will amount to R551. 4*a*. in 2 years at 5 per cent. compound interest ?

$$\text{Principal} \times (\tfrac{105}{100})^2 = \text{R}551{\cdot}25.$$

$$\therefore\ \text{Principal} = \text{R}551{\cdot}25 \times (\tfrac{100}{105})^2.$$

$$= \text{R}500.$$

EXAMPLES. 159.

Find, (by the method of Art. 234) to the nearest pie, the amount, at compound interest, of

1. R1000 in 2 yr. at 5 p. c.
2. R300 in 3 yr. at 3 p. c.
3. R700 in $2\frac{1}{2}$ yr. at 4 p. c.
4. R750 in 3 yr. at $4\frac{1}{2}$ p. c.
5. R2000 in $2\frac{1}{4}$ yr. at 4 p. c.
6. R4000 in $2\frac{3}{8}$ yr. at 3 p. c.
7. R1 in $1\frac{1}{2}$ yr. at $3\frac{1}{2}$ p. c.
8. R10 in $3\frac{1}{4}$ yr. at $3\frac{1}{4}$ p. c.
9. R3000 in $1\frac{1}{2}$ yr. at 6 p. c. per annum, interest being due half-yearly.
10. R350 in $1\frac{3}{4}$ yr. at 4 p. c. per annum, interest being due quarterly.

What sum lent at compound interest will amount to

11. £100 in 2 yr. at 5 p. c.? **12.** £132. 6*s*. in 2 yr. at 5 p. c.?

13. £270. 8*s*. in 2 yr. at 4 p. c.? **14.** £3413. 16*s*. in $2\frac{1}{4}$ yr. at 4 p.c.?

15. £1000 in $3\frac{1}{2}$ yr. at 6 p. c.? **16.** £1 in $3\frac{3}{4}$ yr. at 8 p. c.?

MISCELLANEOUS EXAMPLES. 160.

1. Find the difference between the simple and compound interest on R500 for 3 years, at 4 p. c.

2. Prove that the amount at compound interest for 2 years at 2 per cent. is 1·0404 times the principal.

3 Prove that the difference between the simple and compound interest for 3 years at 5 per cent. is ·007625 times the principal.

4. The difference between the simple and compound interest on a certain sum of money for 2 years at 4 p. c. is R1; find the sum.

5. A person at the beginning of each year lays aside R1000, and employs the money at 5 p. c. compound interest; how much will he be worth at the end of 3 years?

6. The population of a town is 64000 and its annual increase is 10 per cent.; what will be the number of its inhabitants at the end of 3 years?

7. A merchant commenced with a certain capital, and gained annually at the rate of 30 per cent. At the end of 3 years he is worth R21970. What was his original capital?

8. A money-lender borrows money at 4 per cent. per annum, and pays the interest at the end of the year; he lends it at 6 per cent. per annum payable half-yearly, and receives the interest at the end of the year: by this means he gains R104. 8*a*. a year: how much money does he borrow?

XLIX. PRESENT WORTH AND DISCOUNT.

235. The **Present Worth** or **Present Value** of an amount due at the end of a given time is that sum which with its interest for the given time will be equal to the amount.

Discount is the allowance made for the payment of a sum of money before it is due.

From the definition of present worth, it follows that a debt which is due at some future period is equitably discharged by paying the present worth at once Hence *discount is equal to the interest on the present worth*. And *Amount = Present Worth + Discount*

Example 1. Find the present worth of R825, due $2\frac{1}{2}$ years hence, reckoning interest at 4 per cent.

[*N. B.* This corresponds to *Ex.* 3, Art. 232.]

R100 amounts to R110 in $2\frac{1}{2}$ years at 4 p. c.

$\because$ Present worth of R110 = R100,

$\therefore$ .... R1 $= R\frac{100}{110}$.

$\therefore$ .... R825 $= \frac{100 \times 825}{110}$

$= 750$. *Ans.*

[Discount = R825 − R750 = R75.]

EXAMPLES. 161.

Find the present worth of

1. R204, due 4 years hence, interest at 5 per cent.
2. R1518. 12*a*, due in 4 years, at $5\frac{5}{8}$ per cent.
3. R3776. 4*a*., due 18 months hence, at 4 per cent.
4. £1522. 1*s*. 6*d*, due 3 years hence, at $4\frac{2}{3}$ per cent.
5. £1607. 18*s*. 4*d*., due $4\frac{1}{2}$ years hence, at 3 per cent.
6. £1156. 2*s*. 8*d*., due $3\frac{1}{3}$ years hence, at $4\frac{1}{2}$ per cent.
7. R1626, due 4 months 10 days hence, at $4\frac{1}{2}$ per cent.
8. R183, due 25 days hence, at 4 per cent.
9. R24845. 15*a*, due 3 years hence, at $7\frac{1}{2}$ per cent. compound interest.
10. £1050. 12*s*. 6*d*., due 2 years hence, at $2\frac{1}{2}$ per cent. compound interest.

Example 2. Find the discount on R600, due 4 years hence, interest being reckoned at 5 per cent.

Interest on R100 for 4 years at 5 p. c. = R20.

$\therefore$ Discount on R120 = R20,

$\therefore$ .... R1 $= R\frac{20}{120}$,

$\therefore$ .... R600 $= R\frac{20 \times 600}{120}$

$= R100$. *Ans.*

[Present worth = R600 − R100 = R500.]

EXAMPLES. 162.

Find the discount on

1. R355. 4*a* due 4 months hence, at $4\frac{1}{2}$ per cent. interest.

2. R2830. 3*a*. 4*p*., due 7 months hence, at 5 per cent.
3. R6901. 14*a*., due 9 months hence, at 3 per cent.
4. R2980. 6*a*. 8*p*., due 11 months hence, at 4 per cent.
5. £370. 4*s*. $8\frac{1}{4}$*d*., due 15 months hence, at $4\frac{5}{8}$ per cent.
6. £275. 6*s*. 8*d*., due $1\frac{1}{3}$ years hence, at $4\frac{1}{2}$ per cent.
7. £241. 12*s*. 4*d*., due 146 days hence, at $4\frac{1}{2}$ per cent.
8. £121. 15*s*., due 5 months hence, at $3\frac{1}{2}$ per cent.
9. R5208. 12*a*., due $3\frac{1}{2}$ years hence, at $4\frac{1}{2}$ per cent.
10. R2516. 4*a*., due 3 yr. 9 mo. 18 da. hence, at $6\frac{1}{4}$ per cent.
11. R6077. 8*a*. 6*p*., due 4 years hence, at 5 p. c. compound interest.
12. £413. 8*s*. 9*d*., due 2 years hence, at 5 p. c. compound interest.

236. Inverse questions.

Example 1. If the discount on R282. 8*a*. is R32. 8*a*., reckoning interest at 4 per cent., when is the amount due?

* [*N. B.* This corresponds to *Ex.* 2, Art. 232.]

Amount = R282. 8*a*.; discount = R32. 8*a*.; ∴ present worth = R250.

∴ Interest on R250 for the required number of years = R32. 8*a*.; and interest on R250 for 1 year at 4 per cent. = R10;

∴ the required number of years $= \dfrac{\text{R}32.\ 8a.}{\text{R}10} = 3\frac{1}{4}$.

∴ The amount is due $3\frac{1}{4}$ years hence.

EXAMPLES. 163.

When is the sum due, if the

1. discount on R1010. 10*a*. at 5 per cent. interest is R91. 14*a*.?
2. discount on R1518. 12*a*. at $5\frac{5}{8}$ p. c. is R268. 12*a*.?
3. discount on £520 . 17 . 6 . at $4\frac{1}{2}$ p. c. is £70 . 17 . 6?
4. discount on £5747 at $3\frac{1}{2}$ p. c. is £147?
5. present worth of R3850 at 4 p. c. is R3500?
6. P. W. of R15941. 6*a*. 6*p*. at $3\frac{3}{4}$ p. c. is R13750?
7. P. W. of £8776. 6*s*. $10\frac{3}{4}$*d*. at $2\frac{1}{2}$ p. c. is £8721. 16*s*. 8*d*.?

Example 2. If the discount on R528. 12*a*., due $3\frac{1}{2}$ years hence, be R78. 12*a*., at what rate per cent. is the interest calculated ?

[*N. B.* This corresponds to *Ex.* 1, Art. 232.]

Amount = R528. 12*a*.; discount = R78. 12*a*. ; ∴ present worth = R450.

Interest on R450 for $3\frac{1}{2}$ years = R78. 12*a*. ;

∴ ....R1 for $3\frac{1}{2}$ years = R$\frac{78\frac{3}{4}}{450}$;

∴ ....R1 for 1 year = R$\frac{78\frac{3}{4}}{450 \times 3\frac{1}{2}}$;

∴ ....R100 for 1 year = R$\frac{78\frac{3}{4} \times 100}{450 \times 3\frac{1}{2}}$ = R5.

∴ Rate per cent. = 5.

EXAMPLES. 164

What is the rate of interest, if the

1. discount on R350, due 2 years hence, is R100 ?
2. discount on R7480, due 4 years hence, is R680 ?
3. discount on £397 . 2 . $2\frac{2}{5}$, due 4 years hence, is £71 . 12 . $2\frac{2}{5}$?
4. discount on £538 . 10 . $7\frac{1}{10}$, due $2\frac{3}{4}$ years hence, is £37 . 17 . $3\frac{1}{10}$?
5. present worth of R1260, due 4 years hence, is R1125 ?
6. P. W. of R2673. 2*a*, due $3\frac{1}{2}$ years hence, is R2275 ?
7. P. W. of £2857. 10*s*., due $12\frac{1}{2}$ years hence, is £2000 ?

237. Miscellaneous questions on P. W. and Discount.

Example 1. On what sum of money, due at the end of 2 years, does the discount, at 4 per cent., amount to R20 ?

Here, interest on P. W. for 2 years = R20.

Now, R8 is the interest for 2 years on R100,

∴ R4 ....R50,

∴ R20 ....R250 ;

the P. W. = R250 ; and ∴ amount = R270. *Ans*

Example 2. If the interest on R500 at 5 per cent. be equal to the discount on R575, when is the latter sum due ?

Here, R500 = P. W. of R575 ; ∴ R75 = interest on R500.

Now, the interest on R500 for the required number of years = R75, but the interest on R500 for 1 year at 5 per cent. = R25 ;

$$\therefore \text{ the required number of years} = \frac{R75}{R25} = 3.$$

∴ The sum is due 3 years hence.

Example 3. The interest on a certain sum of money is R22, and the discount on the same sum for the same time and at the same rate is R20 ; find the sum.

Int. on the sum = Int. on P. W. + Int. on Disc.
= Disc on the sum + Int. on Disc.

∴ Int. on the sum − Disc. on the sum = Int. on Disc.

Hence R2 = Int. on R20,

∴ R22 = ... R220. *Ans.*

Note. It should be carefully noted that *the difference between the interest and discount on a sum of money for a certain time and at a certain rate is equal to the interest on that discount for that time and at that rate.*

EXAMPLES. 165.

1. On what sum of money, due at the end of 16 months, does the discount, at $4\frac{3}{4}$ per cent., amount to R484. 8*a.* ?

2. If the discount on a certain sum of money, due 8 months hence, at $2\frac{1}{2}$ per cent., be R883 . 10 . 8, what is the sum ?

3. The discount on a certain sum of money, due at the end of $2\frac{1}{4}$ years, at $2\frac{2}{3}$ per cent., is £32. 10*s.* : find the sum.

4. If the interest on R2275 at $3\frac{1}{2}$ per cent. be equal to the discount on R2593. 8*a.* for the same time and at the same rate, when is the latter sum due ?

5. If the interest on £800 at 3 per cent. be equal to the discount on £838, when is the latter sum due ?

6. If the interest on £148 for 5 years is equal to the discount at the same rate on £173. 18*s.*, due 5 years hence, what is the rate of interest ?

7. The interest on a certain sum of money is R120, and the discount on the same sum for the same time and at the same rate is R100 ; find the sum.

8. The interest on a certain sum of money is R336, and the discount for the same time and at the same rate is R300 ; find the sum.

9. The discount on a certain sum, due 2 years hence, is R50, and the interest on the same sum for 2 years is R56. 4a. : find the sum, and the rate per cent. per annum.

10. The interest on a certain sum, at 5 per cent., for a certain time is £50, and the discount for the same time at the same rate is £40 : find the sum, and the time.

11. If the difference between the interest and discount on a sum for 3 years at 3 per cent. be R1, what is the sum?

12. If the difference between the interest and discount on a certain sum of money for 9 months at 4 per cent. be 15*s*., find the

13. *A* offers for a house R800, and *B* offers R815 to be paid at the end of 4 months. Which is now the better offer, if the rate of interest is 5 per cent. per annum ?

14. A man buys 250 md. of sugar for R2500 payable at the end of 6 months, and the same day sells them at R10 per md. ready money : what does he gain by the transaction, reckoning interest at 5 per cent. per annum ?

15. A tradesman marks his goods with two prices, one for ready money and the other for 6 months' credit : what ratio should the two prices bear to each other, allowing interest at 4 per cent. ? If the credit price of an article be R50, what is the cash price ?

16. Five copies of a book can be bought for a certain sum payable at the end of a year and six copies of the same book can be bought for the same sum in ready money ; what is the *rate of interest* ?

17. The discount on R550 for a certain time is R50 ; what is the discount on the same sum for twice that time ?

18. The interest on £720 for a certain time is £18 ; find the discount on the same sum for the same time.

19. If the discount on a sum of money, due 6 months hence, at 8 p. c. be £7. 10. 11½ ; find the P. W. of the sum.

20. A man bought an estate for £2000 and sold it immediately for £2287. 10*s*. payable at the end of 5 months. If the use of the money be reckoned at 4 per cent. per annum, what is now his gain per cent. ?

21. £259. 7*s*. is due 4 years hence and £173. 18*s*., 5 years hence: what sum at the present time is equivalent to both these sums, calculating interest at 3½ per cent. ?

22. What sum must be paid now in order that a person may receive R2000 at the end of every year for the next 4 years, the rate of interest being 5 per cent. ?

COMMERCIAL DISCOUNT.

238. A **bill** is a promise (in writing) to pay a certain sum of money at the end of a certain time.

Example. Each of the following is a bill: a **Bill of Exchange** or **Hundi** (which is a document in which one person directs another to pay to him, or to some other person, a sum of money at the end of a certain time); a **Promissory Note** (which is a document in which one person promises to pay another a sum of money at the end of a certain time)

239. When a *banker* or *money lender* purchases a bill, that is, advances money at a certain rate per cent. on the security of a bill, instead of deducting discount he usually deducts interest for the time specified adding the 3 *days of grace.* The purchaser of a bill may sell it at any time before it is due. In this case also, the second purchaser deducts interest on the amount for the time the bill has still to run adding the *three days of grace.*

Note 1. There is a *custom,* which has the force of law, by which a bill (*if not payable on demand*) always runs *three days* (called the **days of grace**) beyond the time specified Thus a bill drawn on the 15th January, at 3 months would be **nominally** due on the 15th April, but **actually** due on the 18th Moreover, **calendar months** are always reckoned, so that a bill drawn on the 31st January, at 3 months, would be nominally due on the 30th April and actually on the 3rd May.

Note 2. In working an example the 3 days of grace should be added *only* when the information given in the question is sufficient to enable us to determine the *exact number of days* that must elapse before the bill falls due, *and not otherwise.*

Example. A bill for £505 drawn on the 7th March at 4 months is **discounted** (*i. e., sold*) on the 28th April at 5 per cent.: how much does the holder of the bill receive, interest being deducted?

The bill is nominally due on the 7th but actually due on the 10th July; therefore the bill has still to run from 28th April to 10th July, that is, for 73 days or $\frac{1}{5}$ of a year (including *one only* of the days named).

Now, interest on £505 for $\frac{1}{5}$ yr. at 5 p. c. $= £\frac{505 \times \frac{1}{5} \times 5}{100} = £5.\ 1s.$

$\therefore$ The holder receives £505 − £5. 1*s.*, *i. e.*, £499. 19*s.*

Note 3. A banker in purchasing a bill *obtains a small advantage* by deducting interest instead of discount.

The mathematical discount is called **True** Discount.

Banker's discount (*i. e.*, interest) is called **Commercial** or **Practical** Discount.

The *banker's gain* = the difference between the *commercial* and *true* discount.

Note 4. In Arithmetic 'Discount' is always understood to mean *true* discount (and not *commercial* discount). Therefore in working examples true discount is always to be calculated unless commercial discount is expressly mentioned.

240. A *second kind of commercial discount* (which has no reference to time) is the deduction which is made by a tradesman for immediate payment of his bill. Thus when tradesman gives notice upon his bill that he will allow 10 per cent. discount for immediate payment, he deducts R10 for every R100 in the amount of the bill. The calculation of this discount is therefore the same as of finding the simple interest on the amount of the bill for 1 year at 10 per cent.

EXAMPLES. 166.

1. Find the difference between the commercial and true discount on a bill of R6002. 8*a*., due in 4 months, at $6\frac{1}{4}$ per cent.

2. A bill is drawn for £250 on June 12th at 5 months, and is discounted on Sep. 3rd at 5 per cent. ; how much does the holder of the bill receive, banker's discount being allowed ?

3. Find the banker's discount on a bill of £730 drawn on July 31st at 2 months and discounted on Sep. 3rd at 4 per cent.

4. What does a bill-discounter give as the present worth of a bill for R91. 4*a*. drawn on Sep. 4th at 5 months and discounted the same day at $6\frac{1}{4}$ per cent. ?

5. A bill of R182. 8*a*, nominally due on the 15th of May, is discounted on the 23rd April of the same year at 3 per cent. ; what does the banker gain thereby ?

6. A bill is drawn for £365 on March 31st at 3 months and discounted on June 13th at 4 per cent. ; how much more was charged than the true discount ?

7. The difference between the commercial and true discount on a bill for $7\frac{1}{2}$ months at 5 per cent. is R9 ; find the amount of the bill.

8. The amount of a tradesman's bill is R375 ; if he allows 10 per cent. discount, how much does he accept for immediate payment ?

9. A tradesman accepts £40 for immediate payment of a bill for £50 ; what rate of discount does he allow ?

10. If the credit price of five copies of a book is equal to the cash price of six copies of the same book, what is the *rate of discount*? [cf. Question 16, Ex. 165.]

11. A tradesman's prices are 25 p. c. above the cost price; if he allows his customers a discount of 10 p. c. on his bill, what profit does he make?

12. How much per cent. must a tradesman add on to the cost price of his goods, that he may make 20 per cent. profit after allowing his customers a discount of 10 p. c. on his bill?

L. EQUATION OF PAYMENTS.

241. When several sums are due from one person to another, payable at different times, we may be required to find the time at which they may all be paid together, so that neither the creditor nor the debtor may lose. The time so found is called the **equated time** of payment.

We give below a rule for finding the *equated time*, which will be found sufficiently accurate for all practical purposes

Rule. Multiply each debt by the number of months [or days] after which it is due: then divide the sum of the products by the sum of the debts: the quotient will be the number of months [or days] in the equated time.

Example. If ₨400 be due from *A* to *B* at the end of 8 months, and ₨600 at the end of 10 months, when may both sums be paid in a single payment?

Number of months in the equated time $= \frac{400 \times 8 + 600 \times 10}{400 + 600} = 9\frac{1}{5}$. *Ans.*

EXAMPLES. 167.

1. ₨200 is due in 5 months and ₨400 in 8 months; find the equated time of payment.

2. ₨450 is due 2 months hence, ₨400 is due 3 months hence and ₨250 is due 4 months hence; what is the equated time?

3. Find the equated time of payment of £600, one-half of which is due in 6 months, $\frac{1}{3}$ in 9 months, and the rest in a year.

4. *A* owes *B* a debt payable in $4\frac{7}{12}$ months, but he pays $\frac{1}{4}$ in 3 months, and $\frac{1}{3}$ in 4 months; when ought the remainder to be paid?

5. *A* owes *B* on the 10th of April ₨900 due 40 days hence; he pays ₨400 on the 10th of May and ₨300 on the 20th of the same month: on what date ought he to pay the rest?

LI. STOCKS.

242. **Stock** is the name given to the money borrowed by any **Government** to meet national expenses, or to the *Capitals of Trading Companies.*

The money borrowed by a Government is called the **National** or **Public Debt**. The money lent to the Government is said to be in **Government Securities** or **Government Promissory Notes** in India, and in the **Funds** in England. A part of the National Debt in England is called the **Consolidated Annuities** or **Consols**.

When any Government raises capital by borrowing, it reserves to itself the option of paying off the principal at any future time, but promises to pay the interest at fixed periods. In India and England the interest is paid *half-yearly*.

The Capital of a Trading Company is divided into **Shares**, generally of R100 or £100 each; those who join the company by buying one or more of these shares are called **Shareholders**. The shareholders are not required to pay the full price of their shares at once, but they have to pay it in instalments, as the business of the company progresses and **Calls** are made The part of the capital of the company, which has thus been paid at any time, is called the **Paid-up Capital**. The profits of the company are divided periodically among the shareholders; and the moneys thus received are called **Dividends**

When all the capital of a company has been subscribed and the company is in need of more capital, it is not usual to issue more shares like those issued at first. The company generally borrows money at a fixed rate of interest and agrees to pay the interest on this money before any dividend on the original shares is paid. Money so borrowed is called the **Preference Stock** of the company, the original capital being called the **Ordinary Stock.**

The *bonds* which are given by Joint-Stock Companies, Municipalities and similar other bodies for *borrowed capital* are called **Debentures.**

243. Stock is transferrable by sale; but its price varies from a variety of causes. When the *market value* of R100 stock is R100 cash, the stock is said to be **at par**; when R100 stock is sold for R98, it is said to be **at a discount of 2 per cent.** or, **at 2 below par**; when it is sold for R102, it is said to be **at a premium of 2 per cent.**, or, **at 2 above par.**

Purchases and sales of stock are usually made through *Brokers* who generally charge $\frac{1}{8}$ per cent. *on the stock bought or sold.* Thus, if the market value of R100 stock is R$97\frac{1}{2}$, the purchaser has to pay R$(97\frac{1}{2}+\frac{1}{8})$ and the seller receives R$(97\frac{1}{2}-\frac{1}{8})$.

Note. By "the 3 per cents." or "3 per cent. stock" is meant a stock, on R100 (or £100) of which is paid a dividend of R3 (or £3) per annum.

N. B. Unless the brokerage is mentioned, it need not be taken into consideration in working examples in stocks.

244. *Example* 1. What is the cost of R1500 stock in the 4 per cents. at $97\frac{7}{8}$, brokerage being $\frac{1}{8}$ per cent. ?

$$\text{Cost of R100 stock} = \text{R}(97\tfrac{7}{8} + \tfrac{1}{8}) = \text{R}98,$$

$$\therefore \text{ .... R1500 .... } = \text{R}98 \times 15 = \text{R}1470. \quad \textit{Ans.}$$

Example 2. How much stock at $97\frac{1}{2}$ (brokerage included) can be bought for R390 ?

Amount of stock bought for R$97\frac{1}{2}$ = R100

$$\therefore \text{ .... R1 } = \text{R}\frac{100}{97\frac{1}{2}},$$

$$\therefore \text{ .... R390 } = \text{R}\frac{100 \times 390}{97\frac{1}{2}}$$

$$= \text{R}\frac{100 \times 390 \times 2}{195}$$

$$= \text{R}400. \quad \textit{Ans.}$$

N. B. It is obvious that we have nothing to do with the rate of interest in any of the two above examples.

EXAMPLES. 168.

1. Find the cost of R2000 of 4 per cent. stock at 95.

2. Find the cost of £250 in the 3 per cent. consols at 3 below par, brokerage being $\frac{1}{8}$ p. c.

3. How much money can be obtained from the sale of R4500 stock in the Calcutta Municipal Debentures at R12 premium ? (Brokerage $\frac{1}{8}$ p. c.)

4. Find the price of the 4 per cents. when R800 stock can be purchased for R750. (B. $\frac{1}{8}$ p. c.)

5. Find the price of the $4\frac{1}{2}$ per cents. when R1700 is obtained from the sale of R1600 stock. (B. $\frac{1}{8}$ p. c.)

How much stock can be purchased by investing

6. R1350 in the 4 per cents. at R10 discount ?

7. R5062. 8*a*. in the 5 per cents. at $12\frac{3}{8}$ above par ? (B. $\frac{1}{8}$ p. c.)

8. £6909. 18*s*. in the consols at $92\frac{3}{4}$? (B. 2*s*. 6*d*. per cent.)

9. A person lays out R3750 in the purchase of 4 per cent. Govt. Securities at $93\frac{3}{8}$ and afterwards sells at $95\frac{3}{8}$; what profit does he make, the usual brokerage being charged on each transaction ?

10. A person buys £1000 3 per cent. stock at $98\frac{5}{8}$ and sells out at $96\frac{7}{8}$; how much does he lose by the transaction? (B. $\frac{1}{8}$%.)

11. A person bought Russian 5 per cent. stock at 72, and sold it when the price has risen to $75\frac{3}{4}$, thereby clearing £65; how much money did he lay out?

12. A person holds £4800 consols; if he sells out at $87\frac{3}{8}$ and invests the proceeds in the $2\frac{1}{2}$ per cents. at 81, how much of the latter stock will he hold?

13. A person invested £5330 in the 3 per cents. at 91, and when they had risen $1\frac{3}{4}$ per cent. he sold out and invested the money in the stock of the Dominion of Canada at $102\frac{1}{2}$; how much Canadian stock does he hold?

Example 3. What annual income will be derived from R3725 of $4\frac{1}{2}$ per cent. stock?

Income from R100 stock $=$ R$4\frac{1}{2}$,

$\therefore$ .... R1 .... $=$ R$\frac{9}{2\times100}$,

$\therefore$ .... R3725 .... $=$ R$\frac{9\times3725}{2\times100}$ $=$ R167. 10*a*. *Ans.*

N. B. This is merely a case of finding the interest, where the given stock is the principal.

Example 4. What annual income will be derived from R2042. 8*a*. invested in the 4 per cent. Govt. Securities at 102 (B. $\frac{1}{8}$%)?

Cost of R100 stock $=$ R$102\frac{1}{8}$,

$\therefore$ Income on R$102\frac{1}{8}$ money $=$ R4,

$\therefore$ .... R1 .... $=$ R$\frac{4\times8}{817}$,

$\therefore$ .... R$2042\frac{1}{2}$......... $=$ R$\frac{4\times8\times4085}{817\times2}$ $=$ R80. *Ans.*

Example 5. A person transfers R8000 stock from 4 per cent. Govt. Securities at $98\frac{5}{8}$ to 6 per-cent. Municipal Debentures at $131\frac{5}{24}$; find the alteration in his income, the usual brokerage being charged on each transaction.

Income from the 4 per cents. $=$ R$8000\times\frac{4}{100}$ $=$ R320.

Money obtained from the sale of 4 per cents. $=$ R$8000\times\frac{98\frac{1}{2}}{100}$.

Income from R$131\frac{1}{3}$ invested in 6 per cents. $=$ R6,

$\therefore$ .... R1 .... $=$ R$\frac{6}{131\frac{1}{3}}$,

$\therefore$ .... R$\frac{8000\times98\frac{1}{2}}{100}$ .... $=$ R$\frac{6\times8000\times98\frac{1}{2}}{131\frac{1}{3}\times100}$

$=$ R360.

$\therefore$ The alteration in income is R360 $-$ R320, or R40 *increase*.

Example 6. How much money must a person invest in the $4\frac{1}{2}$ per cent. Preference Stock of the O. E. Ry. Co at $94\frac{1}{2}$ (brokerage included) to obtain an annual income of R600 ?

Money to be invested for R$4\frac{1}{2}$ income = R$94\frac{1}{2}$,

$\therefore$ .... R1 .... = R$\frac{94\frac{1}{2}}{4\frac{1}{2}}$,

$\therefore$ .... R600 .... = R$\frac{94\frac{1}{2} \times 600}{4\frac{1}{2}}$

= R12600. *Ans.*

Example 7. Find the price of 4 per cent. stock when from the investment of R3900 a person obtains an annual income of R160, brokerage being neglected.

Cost of stock producing R160 income = R3900,

$\therefore$ .... R1 .... = R$\frac{3900}{160}$,

$\therefore$ .... R4 .... = $\frac{3900 \times 4}{160}$

= R$97\frac{1}{2}$. *Ans.*

EXAMPLES. 169.

1. Find the half-yearly dividend on R3500 4 per cent. stock.

2. What annual income will be derived from R37250 of $4\frac{1}{2}$ per cent. stock, after paying an income-tax of 4*p*. in the R ?

3. What amount of $3\frac{3}{4}$ per cent. stock must be bought to produce a quarterly income of £375 ?

4. What annual income will be derived from the investment of R5910 in the $4\frac{1}{2}$ per cents. at $98\frac{3}{8}$? (B. $\frac{1}{8}$%).

5. A person invests £25935 in 3 per cent. stock at 90. If the first year's dividend be invested in the same stock at 91, and the dividend for the second year at 95, what will be his income for the third year ?

6. If I invest R16420 in the E. I. Ry. Preference Stock which pays 5 per cent. and is at $102\frac{1}{2}$, what will my clear income be, after paying an income-tax of 5*p*. in the R ? (B. $\frac{1}{8}$ p. c.)

7. If I lay out R2400 in the $4\frac{1}{2}$ per cents. at 96, and after receiving the half year's dividend sell out when they have sunk to 94, how much do I gain ?

8. A person bought Bengal Bank shares at 113, and after receiving the half-year's dividend at the rate of 12 per cent. per annum sold out at $117\frac{1}{2}$, and made a profit of R178. 8*a*. in all ; how many shares did he buy ?

9. If a person invest R18810 in the 4 per cents. at $104\frac{1}{2}$, at

what price must he sell out after receiving the half-year's dividend to make a profit of R450 ?

10. A person transfers £11000 from the 4 per cents. at 92 to the 5 per cents. at 110 ; find the alteration in his income.

11. How much stock can be purchased by the transfer of R4000 stock from the 3 per cents. at 90 to the $3\frac{1}{2}$ per cents. at 96, and what change in annual income will be produced by the transfer ?

12. A person invested R5800 in the 5 per cent. Calcutta Municipal Debentures at par, and after receiving the half-yearly dividend he sells out at R$2\frac{1}{2}$ premium, and invests the entire proceeds in the 4 per cent. Government Securities at $95\frac{5}{8}$; what change is made thereby in his income ?

13. A person laid out R14500 in the $3\frac{1}{2}$ per cents at $72\frac{1}{2}$, and when they had fallen to 68 he sold out and invested the money in the 4 per cents. at $75\frac{5}{8}$; find his gain or loss in income.

14. A person has an annual income of R480 from stock in the 4 per cents. ; this stock he sells out at $95\frac{3}{4}$ and invests the money in a railway stock (paying 5 p. c) at $119\frac{1}{8}$: find the alteration in his income. (B. $\frac{1}{8}$ p. c)

15. How much money must a person invest in the 3 per cent. consols at $91\frac{3}{8}$ to obtain an annual income of £1000 ? (B. $\frac{1}{8}$ p. c.)

16. How much must a person invest in the 4 per cents. at $93\frac{3}{4}$ in order to have a clear income of R940 after paying an income-tax of 4*p.* in the R ?

17. How much 3 per cent stock at par must a man sell in order to purchase enough 4 per cent. stock at $114\frac{3}{8}$ to produce an income of R252, a brokerage of $\frac{1}{8}$ p. c. being charged on each transaction ?

18. Find the price of the 4 per cents. when the investment of R3750 in them produces an income of R160.

19. What is the price of the $4\frac{1}{2}$ per cents. when a man has an income of R270 by investing R7800 in them ? (B. $\frac{1}{8}$ p. c.)

20. A man invests £1570 in the New 4 per cent. Egyptian Annuities, and has thereupon a clear annual income of £76, after paying an income-tax of 1*s.* in the £ ; find the price of the Annuities. (B $\frac{1}{8}$ p. c.)

Example 8. What rate of interest is obtained on money invested in the 4 per cents. at $79\frac{7}{8}$? (B. $\frac{1}{8}$ p. c.)

Interest obtained on R80 money = R4,

∴ .... R20 .... = R1,

∴ .... R100......... = R5,

∴ Rate of interest obtained is 5 per cent.

Example 9. At what price (including brokerage) would a person have to purchase the $4\frac{1}{2}$ per cents. to get 5 per cent. for his money ?

R5 = interest on R100 money,

∴ R1 = ... R20 ....,

∴ R$4\frac{1}{2}$ = ...R90 ....,

∴ the stock must be bought at 90.

Example 10. What is the better stock to invest in, 4 per cents. at 95 or $4\frac{1}{2}$ per cents. at 105 ?

In the first case, interest on R95 money = R4,

∴ .... R1 .... = R$\frac{4}{95}$;

in the second case, ... R105 .... = R$\frac{9}{2}$.

∴ .... R1 .... = R$\frac{9}{210}$.

It will be found that $\frac{9}{210}$ is greater than $\frac{4}{95}$; and therefore the second is the better investment.

Example 11. A person finds that if he invests his money in the 4 per cents. at 98 his income will be R42 less than if he invests it in the 5 per cents. at 112 ; find the sum to be invested.

In the first case, income from R1 = R$\frac{4}{98}$;

in the second case, ... R1 = R$\frac{5}{112}$;

∴ difference of income from R1 = R$\frac{5}{112}$ − R$\frac{4}{98}$ = R$\frac{3}{112 \times 7}$.

Now, R$\frac{3}{112 \times 7}$ = difference of income from R1,

∴ R1 = ... R$\frac{112 \times 7}{3}$,

∴ R42 = ... R$\frac{112 \times 7 \times 42}{3}$

or R10976. *Ans.*

EXAMPLES. 170.

What rate of interest is obtained by investing in the

1. 4 per cents. at 90 ? **2.** 3 per cents. at 70 ? (B. $\frac{1}{8}$ p. c.)

3. A person buys £800 3 per cent. consols at 85, and £500 more when they are at 97 ; how much per cent. will he get for his money after deducting an income-tax of *7d.* in the £ ?

4. What rate of interest do I get upon my money, if I buy Railway Shares of R75 each (which pay 4 per cent.) at 85 and pay an income-tax of *4p.* in the R ?

5. At what price would a person have to purchase the 4 per cents. to get $5\frac{1}{3}$ per cent. on his money ?

6. What is the price of stock, when the $4\frac{1}{2}$ per cents. pay interest at the rate of 6 p. c. on the money invested ? (B. $\frac{1}{8}$ p. c.)

7. When the 4 per cents. are at 88, what ought to be the price of the $4\frac{1}{2}$ per cents. to give the same rate of interest ?

8. A man invested in the 4 per cents. ; if, after deducting an income-tax of 6*p*. in the rupee, he obtained $4\frac{1}{2}$ per cent. interest on the money invested, at what price did he buy ?

9. If Bank stock bought at 14 per cent. discount pay $6\frac{1}{2}$ per cent. on the investment, how much per cent. would it pay if it were bought at 28 per cent. premium ?

10. Which is the better investment, 4 per cents. at 82 or 5 per cents. at 102 ?

11. Which is the better stock to invest in, $3\frac{1}{2}$ per cents. at $82\frac{1}{2}$ or 4 per cents. at $100\frac{1}{2}$? (B. $\frac{1}{8}$ p. c.)

12. Find the difference per cent. in income between investing in the 4 per cents. at 88 and $4\frac{1}{2}$ per cents. at 90.

13. A person finds that if he invests his money in the $4\frac{1}{2}$ per cents. at 96 his income will be greater by R10 than if he invests it in the 4 per cents at 88 ; find the money to be invested.

14. By investing a certain sum of money in the 3 per cents. at 75 a man gets £5 . 13 . 4 less in income than he would get by investing the same sum in the $3\frac{1}{2}$ per cents. at 84 ; find the sum invested

MISCELLANEOUS EXAMPLES. 171.

1. A person invested money in the 4 per cents. when they were at 95, and some more when they were at 90 ; find the advantage per cent. of the second purchase over the first.

2. A person invests R16600 in the 3 per cents at 83, and when the funds have risen 7 per cent. he transfers $\frac{3}{4}$ of his capital to railway stock at $67\frac{1}{2}$; what dividend ought the latter to pay that he may thereby increase his income by R50 ?

3. Which is the better investment, £1256 in the $3\frac{1}{2}$ per cents. at 87, or in the railway shares at £89 per share, the dividends in the latter case being $3\frac{3}{4}$ per cent. on the sum invested ?

4. A person possesses £3100 3 per cents., which he sells at $99\frac{3}{4}$; he invests the proceeds in railway shares at £56 a share, which shares pay 5 per cent. interest on £45, the amount paid on each share. By how much is his income altered by the transaction ?

5. A person has R5000 stock in the 3 per cents. which he sells and re-invests in the $3\frac{1}{2}$ per cents. as $87\frac{1}{2}$ and increases his income by R5 ; find the price of the 3 per cents.

6. By selling £1500 3 per cents. at 95 and re-investing it I increase my income by £15 a year. If the dividend on the new shares is 8 per cent., what is the price of them ?

7. What sum must be invested in the 3 per cents. at 90 to amount in $23\frac{1}{3}$ years at simple interest to £3210 cash ; the price of

the stock remaining unchanged ? How many years sooner would the amount be realized if the price of the stock rose to 96 ?

8. A gentleman in India has been receiving 12 per cent. on his capital ; he goes to England, invests it in the 3 per cents. at $94\frac{3}{8}$, and his income in England is £2400 a year : what was his income in India ? (£1 = ₨10)

9. How much 3 per cent. stock must be sold at $87\frac{1}{2}$ to pay the present worth of ₨1645. 14*a*. due 10 months hence, at $3\frac{3}{4}$ per cent. ?

10 . Municipal Debentures are at 119 when the Government Securities are at $93\frac{1}{2}$, what should be their price when the Government Securities are at $71\frac{1}{2}$?

11. What is the price of the 4 per cents. when $\frac{1}{21}$ of the sum invested is received as annual interest after deducting an income-tax of 4 pies in the rupee ?

12. A person invests ₨23800 partly in a $4\frac{1}{2}$ per cent. stock at $97\frac{1}{2}$ and partly in the 3 per cents. at par : if he holds twice as much 3 per cents. as $4\frac{1}{2}$, find the income that he obtains from the whole investment.

13 A man having money invested in the 3 per cents., from which he derives an income of £864, sells out at 90. and invests in shares that pay 5 per cent. interest : if his income be now increased by £336, at what price does he buy the shares ?

14. What sum must have I invested in the $3\frac{1}{2}$ per cents. at 91 if, after investing £4000 more in the 3 per cents at 75, and paying an income tax of 7*d*. in the £ on my total gross receipts, I find my net income to be £524. 5*s*. ?

15. A person who has a certain capital calculates that if he invest half his capital in the 3 per cents. at 90, and half in the 4 per cents. at par, his total income will be ₨1100 ; what is his capital ?

16. *A* invests £3500 in buying equal amounts of 3 per cents, at $78\frac{1}{8}$ and 6 per cents. at $169\frac{3}{8}$ *B* invests the same sum, half in one stock and half in the other. Find (i) the difference in their incomes, (ii) the ratio of their rates of interest.

17. Four per cents. are at 95, and $4\frac{1}{2}$ per cents. are at 105. One person buys ₨200 stock in each, and another person invests ₨200 in each : compare the rates of interest obtained by the two on their whole investments.

18. A shareholder receives one year a dividend of 10 per cent. on his stock and pays an income-tax of 4 pies in the rupee. The next year he receives dividend of 12 per cent. and pays an income-tax of 5 pies in the rupee. If his income is ₨394 5 . 4 more in the latter than in the former year, how much stock does he hold ?

19. 20 shares in a company are worth ₨1600 when the dividend is at the rate of 5 per cent. ; how many shares ought to be worth ₨960 when the dividend is at 6 per cent. ?

20. A person invested ₨2800 in the purchase of 4 per cents. at 90 and $4\frac{1}{2}$ per cents. at 95. If his total income is ₨130, how much of each stock did he buy ?

21. A man invests £1600 in the 4 per cent. stock at 80 and $7\frac{1}{2}$ per cent. stock at 125 ; what sums must he invest in the respective stocks to make $5\frac{3}{4}$ per cent. on his money ?

22. A person, by selling 4 per cents. at 87 and investing the proceeds in the 5 per cents at 96, finds that his income is increased by ₨17 : how much 4 per cents. did he sell ?

23. 4 per cent. stock, bought at $95\frac{7}{8}$, is held for 6 months at the end of which time the interest is paid ; it is then sold at the same price at which it was bought : find the rate per cent. per annum of interest obtained for the money used. (Usual brokerage.)

24. A person invests ₨255 in the 4 per cents. at 85, and sells part of his stock when they have risen 5 per cent. and the remainder when they have fallen 8 per cent ; he lost ₨11 by the transaction : how much stock did he sell out at first ?

25. 5 per cent. stock is sold at 108, and with the proceeds 4 per cent stock is bought at $91\frac{1}{4}$; after a time 4 per cent. stock is sold at $95\frac{5}{8}$ and the original stock purchased at 109, leaving a profit of ₨109 on the transaction : find the amount of 5 per cents. sold.

26. If the 3 per cents. be at 95 and the Government offer to receive tenders for a loan of £5,000,000, the lender to receive £5,000,000 stock in the 3 per cents. together with a certain sum in the $3\frac{1}{2}$ per cents., what sum in the $3\frac{1}{4}$ per cents. ought the lender to accept ?

27. The present income of a railway company would justify a dividend of 6 per cent., if there were no preference shares ; but as £50,000 of the stock consists of such shares which are guaranteed $7\frac{1}{2}$ per cent. per annum, the ordinary shareholders get only 5 per cent. : find the amount of the ordinary stock of the company.

28. A person buys 6 per cent. bonds, the interest on which is, payable yearly and which are to be paid off at par 1 year after the time of purchase ; if money be worth 5 per cent., what price should be given for the bonds ?

LII. EXCHANGE.

245. Exchange means the giving or receiving a sum of money of one country equal in value to a given sum of money of another country.

The par of exchange between two countries denotes the *intrinsic* value of a coin of one country, as estimated in terms of a coin of the other country.

The **course of exchange** is the *actual* or *marketable* value at any time of a coin of one country, as estimated in terms of a coin of the other country.

Thus, the quantity of gold in the English Sovereign being 1·261 times the quantity of gold in the French Napoleon, at par of exchange £1 is equal to 1·261 Napoleons; but in the course of exchange £1 may be equal in value to a little more or less than 1·261 Nopoleons.

Arbitration of exchange is the determination of the rate of exchange, called the **arbitrated rate**, between the first and last of a given number of places, when the rates of exchange between the first and second, the second and third, etc., of these places are known.

246. Money transactions between one country and another are usually carried on by means of **Foreign Bills of Exchange** or briefly **Foreign Bills**.

The following is the usual mode of proceeding:

Suppose I want to transmit £100 to a merchant in London. I go to a banker and buy a bill for the given amount, payable in London, at the current rate of exchange; I then send the bill to the merchant in London, who presents it to the person on whom it is drawn and receives the amount.

247. The following table gives the principal foreign monetary systems

France, Belgium, Switzerland	1 franc	=	100 centimes	
Italy ...	1 lira	=	100 centesimi	
Spain ...	1 peseta	=	100 centimos	$= 9\frac{3}{5}d.$ (France to Roumania)
Greece ...	1 drachme	=	100 lepta	
Servia ...	1 dinar	=	100 paras	
Bulgaria ...	1 leva	=	100 stotinkis	
Roumania ...	1 ley	=	100 banis	
Germany ...	1 mark	=	100 pfennige	$= 11\frac{3}{4}d.$
Austria ...	1 florin or gulden	=	100 kreuzers	$= 1s.\ 11\frac{3}{4}d.$
Turkey ...	1 Turkish pound	=	100 piastres	$= 18s.\ 0\frac{3}{4}d.$
Holland ...	1 florin	=	100 cents	$= 1s.\ 8d.$
Portugal ...	1 milreis	=	1000 reis	$= 4s.\ 6d.$
Sweden, Norway, Denmark	1 crown		100 ore	$= 1s.\ 0\frac{3}{4}d.$
United States	1 dollar ($)		100 cents	$= 4s.\ 2d$
Russia ...	1 rouble		100 kopecks	= R1. 12. 3.
China ...	1 tael = 10 mace		100 candareens	= R3.
Japan ...	1 yen		100 sen	= 2. 7. 6.

Note. In the countries whose names have been printed in Italics in the above table, as in India, the standard coins are *silver*; in England the standard coin is *gold*; hence the value of the Rupee, etc, in English money varies with the amount of silver which can be bought for a gold sovereign. For some years past the value of silver as compared with gold has been steadily declining. A few years ago a Rupee was equal in value to about 2*s*., now it is equal to about 1*s*. 3*d*.

Example 1. Calculate the *par of exchange* between the sovereign and the rupee, supposing pure gold to be worth 15 times its weight of pure silver, having given that $46\frac{29}{40}$ sovereigns are coined from 1 lb troy of standard gold, $\frac{11}{12}$ fine, and that a rupee weighs 180 grains of silver and is $\frac{11}{12}$ fine.

The sovereign weighs $\dfrac{12 \times 20 \times 24}{46\frac{29}{40}}$ gr. or $\dfrac{12 \times 20 \times 8 \times 40}{623}$ gr.;

and therefore it contains $\left(\frac{12 \times 20 \times 8 \times 40}{623} \times \frac{11}{12}\right)$ gr. or $\frac{20 \times 8 \times 40 \times 11}{623}$ gr.; of pure gold.

The rupee weighs 180 gr.; and therefore it contains $(180 \times \frac{11}{12})$ gr. or 165 gr. of pure silver, which is equivalent to $\frac{165}{15}$ gr. or 11 gr. of pure gold.

Now the number of rupees equivalent to a sovereign is the same as the number of times 11 gr. is contained in $\frac{20 \times 8 \times 40 \times 11}{623}$ gr.

Hence the sovereign $= \frac{20 \times 8 \times 40 \times 11}{623 \times 11}$ rupees.

$= 10\cdot27\ldots$rupees.

Example 2. Find the relation between the rupee and the shilling as determined from the intrinsic value of the two coins; having given that a rupee weighs 180 grains, and is $\frac{11}{12}$ fine; and that 1 lb. troy of silver, $\frac{37}{40}$ fine, is coined into 66 shillings.

We find, as in the preceding example, that the rupee contains 165 gr of pure silver The shilling contains $\left(\frac{12 \times 20 \times 24}{66} \times \frac{37}{40}\right)$ gr. or. $\frac{24 \times 37}{11}$ gr. of pure silver.

$\therefore$ 1 rupee $= (165 \div \frac{24 \times 37}{11}$ shillings.

$= 2\cdot043\ldots$shillings.

Example 3. Exchange R550 for English money at 1*s*. 8*d*. per rupee.

R1 $=$ 1*s*. 8*d*.,

$\therefore$ R550 $=$ 1*s*. 8*d*. $\times$ 550

$=$ £45. 16*s*. 8*d*. *Ans.*

Example 4. Determine the *course of exchange* between India and England, when Indian money is at a discount of 25 p. c., having given that at par 1 rupee $=$ 2 shillings.

[Indian money being at a discount of 25 p. c. means that it is worth 25 p. c. less English money than it would be if it were at par].

$$\text{At par} \quad R1 = 2s.,$$

$$\therefore \quad \text{at 25 p. c. disc.} \quad R1 = 2s. - \tfrac{1}{4} \text{ of } 2s.$$

$$= 1s.\ 6d.$$

$\therefore$ The course of exchange is 1*s.* 6*d.* per R1.

Example 5. If the rate of exchange between Calcutta and London is at 1*s.* 9*d.* per rupee, and that between London and Paris is at 25 francs per £1, what is the *arbitrated rate of exchange* between Calcutta and Paris?

$R1 = 1s.\ 9d. = £\frac{7}{80} = \frac{7}{80} \times 25 \text{ francs} = 2\frac{3}{16} \text{ francs}.$ (See Art. 205)

$\therefore$ The required rate is $2\frac{3}{16}$ francs per rupee.

EXAMPLES. 172.

1. Convert R3782 to English money, the course of exchange being 1*s.* $5\frac{1}{2}$*d.* per R.

2. Exchange £329. 7*s.* 6*d.* for Indian money at R11. 4*a.* per £.

3. A Spanish pistole is worth 15*s.* and an Austrian ducat 9*s.* 5*d.*; how many ducats are equivalent to 226 pistoles?

4. A French Napoleon or 20-franc piece is worth £·79; find, to the nearest farthing, the value in English money of 123·21 francs.

5. A bill bought in Calcutta at 1*s.* 6*d.* a rupee, is sold in New York at 4*s.* 3*d.* a dollar; determine the course of exchange between New York and Calcutta

6. If £3 = 20 thalers; 25 thalers = 93 francs; 27 francs = 5 scudi; and 62 scudi = 135 gulden; how many gulden can I get in exchange for £11?

7. Find the arbitrated rate of exchange between Vienna and Calcutta in rupees for 1 florin, when the exchange between Calcutta and London is R3 for 5*s.*, between London and Paris is 25 francs for £1, between Paris and Berlin 5 francs for 4 marks, and between Berlin and Vienna 2 marks for 1 florin.

8. If a thaler is equivalent to 40 kreuzers, 10 silber-groschen and half a gulden, and if 30 silber-groschen make a thaler and 60 kreuzers make a gulden, how many gulden are worth 8 thalers?

9. If R1 in England exchanges for 1*s.* $5\frac{1}{2}$*d*, and if £1 in India exchanges for R13. 5*a.* 6*p*, how much do you lose in R960 by the two exchanges?

10. A person in Calcutta wishes to remit a debt of 240 dollars to New York when the exchanges are 1 dollar = R2 13*a.*, R1 = 1*s.* 6*d.* and 25*s.* = 6 dollars. Is it more advantageous for him to remit directly to New York or circuitously through London?

11. A merchant in London is indebted to one at St. Petersburg 15000 roubles : the exchange between St. Petersburg and London is 50*d.* per rouble, between St. Petersburg and Amsterdam 91*d.* Fl. per rouble, and between Amsterdam and London 36*s.* 3*d* Fl per £ sterling. What difference will it make if the London merchant is drawn upon through Amsterdam or direct ?

12. If in London I get £1 for 25 francs 20 centimes, what shall I gain or lose per cent. by taking French money into Bavaria, when the exchange is 11 gulden 40 kreuzers for £1, and 8 gulden 20 kreuzers for a Napoleon ? (1 Napo = 20 fr. ; 1 fr. = 100 centimes ; 1 guld. = 60 kreuz)

13. The Indian bazar maund is equal to $82\frac{2}{7}$ lb. avoir., and the rupee is equal to 2*s.* If 1 md of wheat cost R3, what will be the price in English money of 1 cwt. ?

14. Exchange 380 dollars for English money when it is at a discount of 5 per cent., given that at par 1 dollar = 4*s.* 2*d.*

15. Exchange R660 for English money when it is at a premium of 10 per cent, it being given that at par R1 = 1*s.* $10\frac{1}{2}$*d.*

16. If India exchanges with England at a loss of 15 per cent. when the course of exchange is 1*s.* 5*d.* per R, what is the par of exchange ?

17. A merchant in Calcutta wishes to remit to London R900, a rupee being equal to 2*s.* ; for what sum in English money must he draw his bill when bills *on* London are at a premium of $12\frac{1}{2}$ per cent. ?

18. I pay R51000 to a bank for a bill of exchange payable in London. The rate of exchange is 1*s.* $10\frac{3}{4}$*d* for the rupee, and the bank charges me 2 per cent on the amount payable in England. How much will my agent in London receive ?

19. A person in London owes another in St. Petersburg 460 roubles, which must be remitted through Paris. He pays the requisite sum to his broker when the exchange between London and Paris is 23 francs for £1, and between Paris and St Petersburg 2 francs for one rouble. The remittance is delayed until the rates of exchange are 24 francs for £1, and 3 francs for 2 roubles. What does the broker gain or lose by the transaction ?

20. The exchange of Calcutta on London at 3 months is 1*s.* $4\frac{1}{4}$*d.* per R ; find the exchange at sight, reckoning 5 per cent. per annum.

21. Calculate the par of exchange between the gold mohur, weighing 180 grains, $\frac{11}{12}$ fine, and the U. S. eagle, weighing 258 grains, $\frac{9}{10}$ fine.

22. Calculate the par of exchange between the Napoleon and the rupee, supposing pure gold to be worth 15 times its weight of pure silver ; being given that $16197\frac{1}{2}$ grains of French standard gold, $\frac{9}{10}$ fine, is coined into 155 Napoleons, and that a rupee contains 180 grains of silver, $\frac{11}{12}$ fine.

23. From 3465 grains of fine silver are coined 14 thalers; find the value of a thaler, when a pound troy of Indian standard silver, of which 11 parts out of 12 are fine, is worth R32.

24. If 1 lb. of English standard silver, of which 37 parts in 40 are pure silver be worth 62*s*., find the value of a Hyderabad rupee which weighs 7 dwt. 17 gr., and has a fineness of 30 parts in 31.

25. The gold coinage of one nation contains 1 part of silver to 11 parts of gold; that of another nation, 1 part of silver to 23 parts of gold. It is found that 59 of the first weigh as much as 123 of the second. The intrinsic value of silver is one-sixteenth that of gold. Determine the par of exchance.

LIII. METRIC SYSTEM AND DECIMAL COINAGE.

248. The **Metric System** of weights and measures, which originated in France, has been introduced to a greater or less extent into almost all the countries of Europe. It is also nearly always used in scientific treatises.

In this system,

1. The unit of length is the **Metre.**
2. The unit of area is the **Are.** (= 100 sq. metres.)
3. The unit of solidity is the **Stere.** (= 1 cubic metre.)
4. The unit of capacity is the **Litre.** (= The cube of the tenth part of a metre.)
5. The unit of weight is the **Gramme.** (= The weight, *in vacuo*, of a quantity of distilled water at its maximum density, which fills the cube of the hundredth part of a metre.)

The Tables of Weights and Measures in the Metric System are constructed upon one uniform principle, by attaching the following prefixes to each of the units.

Greek prefixes.			Latin prefixes.		
Deca	means 10	times.	**Deci**	means 10th	part of.
Hecto	 100	....	**Centi**	.... 100th	....
Kilo	 1000	....	**Milli**	.... 1000th	....
Myria	 10000	....			

Thus, A decastere = 10 steres.
A hectare = 100 ares.
A kilolitre = 1000 litres.
A myriametre = 10000 metres.

A decigramme = $\frac{1}{10}$ of a gramme.
A centimetre = $\frac{1}{100}$ of a metre.
A millilitre = $\frac{1}{1000}$ of a litre.

N. B. The *are* is the sq. decametre; the *litre* is the cubic decimetre; the *gramme* is the weight, *in vacuo*, of a cubic centimetre of distilled water at its maximum density.

Note 1. 1 metre = 39·37 inches nearly or about $1\frac{1}{11}$ yards; 1 kilometre = about 5 furlongs. 1 are = about 1076·43 sq. ft.; 1 hectare = about $2\frac{1}{2}$ acres. 1 litre = ·035 cu. ft. nearly = $1\frac{3}{4}$ pints nearly. 1 gramme = 15·43 grains nearly; 1 kilogramme = $2\frac{1}{5}$ lb. avoir. nearly.

Note 2. Act XXXI of 1871 of the Government of India enacts that the unit of weight shall be the **Ser** equal in weight to the French Kilogramme, and the unit of capacity shall be the measure which holds one such Ser of water at its maximum density weighed *in vacuo*. These units, however, have not yet been practically adopted.

FRENCH MONEY.

10 centimes = 1 decime.
10 decimes = 1 franc.

Accounts are kept in francs and centimes only; thus, "32·78 francs" is read 32 francs 78 centimes.

The Franc is a silver coin composed of 9 parts of silver and 1 part of copper, and weighs 5 grammes. It is equal to $9\frac{2}{5}d.$ nearly. The Napoleon is a gold coin = 20 francs.

THE PROPOSED DECIMAL COINAGE OF GREAT BRITAIN.

10 mils (m.) = 1 cent. (c.)
10 cents = 1 florin. (f.)
10 florins = £1.

249. The great advantage of a decimal system of coins, weights and measures is that we can reduce a compound quantity to a simple quantity, and *vice versa*, without going through the process of multiplication and division. Hence the compound rules are replaced by the corresponding simple rules.

Example 1. 7 hectometres 4 decametres 2 metres = 742 metres.

Example 2. 325 centilitres = 3 litres 2 decilitres 5 centilitres.

Example 3. Add together £3. 7f. 2c. 3m., £9. 2f. 0c. 4m., and 7f. 3c.

```
 mils
 3723
 9204
  730
13657 mils = £13. 6f. 5c. 7m.   Ans.
```

Example 4. Multiply 7f. 9c. 3m. by 32.

```
  mils
  793
   32
 1586
2379
25376 mils = £25. 3f. 7c. 6m.   Ans.
```

250 We can easily *decimalise* a sum expressed in £. *s.* *d.* and change decimal coinage into £ *s.* *d.*

Example 1. Express £7. 15*s.* 7½*d.* in decimal coinage.

```
 4 | 2·0
12 | 7·5
20 | 15·625
   £7·78125 = £7. 7f. 8c. 1·25m.   Ans.
```

Example 2. Express £9. 3f. 9c. 8m. in £. *s.* *d.*

```
    £9·398
        20
 s. 7·960
        12
 d. 11·520
```

∴ £9. 3f. 9c. 8m. = £9. 7*s.* 11·52*d.*

LIV. INVOICES AND ACCOUNTS.

251. (i) *Specimen of an Invoice.*

Calcutta, April 23, 1889.

Charles Smith, Esq.,

Bought of William Moran & Co.,

7, Bankshall Street.

	R.	a.	p.
8 yd. of flannel at R1. 4*a*. per yd.	10	0	0
10 yd. of calico at 3*a*. 6*p*. per yd.	2	3	0
2 pairs of gloves at R1. 9*a*. 9*p*. per pair.	3	3	6
R	15	6	6

(ii) *Specimen of an Account,*

Calcutta, June 30, 1889.

Charles Smith, Esq.,

To William Moran & Co ,

7, Bankshall Street.

1889.		R.	a.	p.
April 23,	To goods, as per Invoice	15	6	6
May 7,	To ditto	3	7	3
" 13,	To ditto	9	0	0
June 12,	To ditto		7	6
	R	28	5	3

(iii) *Specimen of a Detailed Account.*

Calcutta, June 30, 1889.

Charles Smith, Esq.,

To William Moran & Co.,

7, Bankshall Street.

1889.		R.	a.	p.
April 23,	8 yd. of flannel at R1. 4*a*. per yd.... ...	10	0	0
"	10 yd. of calico at 3*a* 6*p*. per yd.	2	3	0
"	2 pairs of gloves at R1. 9*a*. 9*p*. per pair ...	3	3	6
May 7,	3 dozen stockings at R6 per doz. ...	18	0	0
May 13,	13 yd. of linen at 8*a*. 6*p*. per yd	6	14	6
June 12,	20 yd. of carpet at R3. 8*a* per yd.... ...	70	0	0
"	4 pairs of socks at R1. per pair	4	0	0
	R	114	5	0

Note. Invoices and Accounts are called **Bills.** Each separate entry in a bill is called an **item.** When an account is sent to a buyer it is said to be **rendered.**

LV. PROBLEMS IN HIGHER ARITHMETIC.

252. *Example* 1. A person has a number of oranges to dispose of; he sells half of what he has and 2 more to *A*, $\frac{1}{3}$ of the remainder and 4 more to *B*, $\frac{1}{4}$ of the remainder and 6 more to *C*; by which time he has disposed of all he had. How many had he at first?

When he had given $\frac{1}{4}$ of his oranges to *C* he had 6 left; therefore this is $(1-\frac{1}{4})$ or $\frac{3}{4}$ of the number he had before *C* came, and therefore he had $6 \times \frac{4}{3}$ or 8 before *C* came; therefore he had $(8+4)$ or 12 before he had given 4 oranges to *B*; but this is the number

he had left when he had given $\frac{1}{3}$ of his oranges to *B*; therefore this is $(1-\frac{1}{3})$ or $\frac{2}{3}$ of the number he had before *B* came, and therefore he had $12 \times \frac{3}{2}$ or 18 before *B* came; therefore he had $(18+2)$ or 20 before he had given 2 oranges to *A*; but this is the number he had left when he had given $\frac{1}{2}$ of his oranges to *A*; therefore he had 20×2 or 40 before *A* came: that is, he had 40 oranges at first.

Example 2. The expenses of a family when rice is at 12 seers for a rupee are R80 a month; when rice is at 15 seers for a rupee the expenses are R77 a month; what will they be when rice is at 18 seers for a rupee?

The prices of a seer of rice in the three cases are R$\frac{1}{12}$, R$\frac{1}{15}$ and R$\frac{1}{18}$ respectively; ∴ the price of a seer is first reduced by R$(\frac{1}{12}-\frac{1}{15})$ or R$\frac{1}{60}$, and finally by R$(\frac{1}{12}-\frac{1}{18})$ or R$\frac{1}{36}$. Now when the saving on a seer of rice is R$\frac{1}{60}$ the total saving is R$(80-77)$ or R3; ∴ when the saving on a seer is R$\frac{1}{36}$ the total saving will be R$\frac{3 \times 60}{36}$ or R5. ∴ The reqd. expenses $=$ R$(80-5) =$ R75.

Or thus: When the saving on each seer of rice is R$\frac{1}{60}$ the total saving is R3; ∴ the number of seers of rice required by the family per month $=$ R$3 \div$ R$\frac{1}{60} = 180$; and the price of 180 seers at 12 seers for a rupee is R15; ∴ the other expenses of the family $=$ R$(80-15) =$ R65. Again, the price of 180 seers at 18 seers for a rupee is R10; ∴ the total expenses when rice is at 18 seers for a rupee will be R$(65+10)$ or R75.

Example 3. A labourer was engaged for 36 days, on the agreement that for every day he worked he should have 4*a*., but that for every day he absented himself he would be fined 2*a*. He received R7. 8*a*. at the end of the time; how many days was he absent?

If he had worked all the 36 days he would have received R9; ∴ through absence he lost (R9 − R7. 8*a*.) or R1 8*a*. But for each day of absence he actually loses (4*a*. + 2*a*.) or 6*a*.; ∴ the number of days he was absent $=$ R1. 8*a*. ÷ 6*a*. $= 4$.

Example 4. I have to be at a certain place in a certain time, and I find that if I walk at the rate of 4 miles per hour I shall be five minutes too late, and if at the rate of 5 miles per hour I shall be 10 minutes too soon; what distance have I to go?

If I walk 4 miles an hour I require 15 minutes more time in going the distance than if I walk 5 miles an hour. And in walking one mile I require 3 minutes more at the former rate than at the latter. Hence I have to go a distance of 5 (*i. e.*, $15 \div 3$) miles.

Example 5. I have a certain sum of money to be distributed among a certain number of boys, and I find that if I give R3 to each I shall spend R4 too little, but that if I give R5 to each I shall spend R6 too much. How much have I to spend?

If I give R5 instead of R3 to each I require R2 more per head and (R4 + R6) or R10 more on the whole; $\therefore$ the number of boys = R10 $\div$ R2 = 5; and $\therefore$ I have to spend (R3 $\times$ 5 + R4) or R19.

Example 6. A lb. of tea and 4 lb. of sugar cost 5*s.*; but, if sugar were to rise 50 per cent. and tea 10 per cent, they would cost 6*s.* 2*d.*: find the cost of the tea and the sugar per lb.

If both tea and sugar were to rise 50 p. c., the cost of 1 lb. of tea and 4 lb. of sugar would be 7*s.* 6*d.*; but tea rises only 10 p. c., $\therefore$ 40 p. c. of the cost of a lb. of tea = 7*s* 6*d.* − 6*s.* 2*d.* = 1*s.* 4*d.*; $\therefore$ the cost of a lb. of tea = 3*s.* 4*d*; $\therefore$ the cost of 4 lb. of sugar = 5*s.* − 3*s.* 4*d.* = 1*s.* 8*d*; and $\therefore$ 1 lb. of sugar costs 5*d.*

Example 7. Three tramps meet together for a meal; the first has 3 loaves, the second 2, and the third, who has his share of the bread, pays the other two 5*d.*; how ought they to divide the money?

Each eats $\frac{5}{3}$ loaves; $\therefore$ the first has given $(3-\frac{5}{3})$ loaves and the second $(2-\frac{5}{3})$ loaves to the third: $\therefore$ the 5*d.* given by the third ought to be divided in the ratio of $(3-\frac{5}{3})$ to $(2-\frac{5}{3})$, *i e*, of 4 to 1; $\therefore$ the first will take 4*d.* and the second 1*d.*

Example 8. The sum of the ages of *A* and *B* is now 45 years, and their ages 5 years ago were as 3 is to 4; find their present ages.

5 years ago the sum of the ages of *A* and *B* was 35 years; if 35 years be divided in the ratio of 3 to 4, the parts are 15 years and 20 years. $\therefore$ The present age of *A* is (15 + 5) or 20 years, and that of *B* is (20 + 5) or 25 years.

Example 9. *A* is twice as old as *B*, and 4 years older than *C*; the sum of their ages is 71 years: find the age of each.

If *C* were as old as *A*, the sum of the ages of *A*, *B*, and *C* would be 75 years; now, dividing 75 in the ratio of 2, 1 and 2, we find that the parts are 30, 15 and 30; $\therefore$ *A*'s age is 30 years, *B*'s 15 years, and *C*'s (30 − 4) or 26 years.

Example 10. *A* and *B* begin business with equal capitals. At the end of the year *A* has gained R600, and *B* has lost $\frac{1}{10}$ of his capital; *A* has then twice as much as *B*. Find how much each had at first.

($\frac{9}{10}$ of *B*'s capital) $\times$ 2 = *A*'s capital + R600,

$\therefore$ ($\frac{9}{10}$ of *A*'s capital) $\times$ 2 = ...,

$\therefore$ $\frac{18}{10}$ or $1\frac{4}{5}$ of *A*'s capital = ...,

i. e., *A*'s capital + $\frac{4}{5}$ of *A*'s capital = *A*'s capital + R600,

$\therefore$ $\frac{4}{5}$ of *A*'s capital = R600,

$\therefore$ *A*'s capital = R600 $\times$ $\frac{5}{4}$ = R750. *Ans.*

Example 11. Divide 250 into two parts such that, 3 times the first part and 5 times the second part may be together equal to 950.

3 times the 1st part + 5 times the 2nd part $= 950$; ...(i)

and the 1st part + the 2nd part $= 250$,

$\therefore$ 3 times the 1st part + 3 times the 2nd part $= 750$: ...(ii)

$\therefore$ 2 times the 2nd part $= 200$, [subtracting (ii) from (i)]

$\therefore$ the 2nd part $= 100$;

and $\therefore$ the 1st part $= 250 - 100 = 150$.

Example 12. Mangoes are bought at R10 per 100 ; at what rate per 100 must they be sold that the gain on R100 may be equal to the selling price of 250 mangoes ?

R100 is the cost price of 1000 mangoes ; $\therefore$ $(1000 - 250)$ or 750 mangoes must be sold for R100 ; $\therefore$ the selling price of 100 mangoes $=$ R$100 \times \frac{100}{750} =$ R$13\frac{1}{3}$.

Example 13. Two passengers going to the same place have 6 md. of luggage between them, and are charged for excess of luggage R4. 8*a.* and R3 respectively : had the luggage all belonged to one person he would have been charged R8. 4*a.* for excess. How much is allowed free ?

R4. 8*a* + R3 is the charge on 6 md. *less* twice the free allowance, and R8. 4*a.* is the charge on 6 md. *less* the free allowance ; $\therefore$ the charge on free allowance = R8. 4*a.* − (R4. 8*a.* + R3) = 12*a.* $\therefore$ (R8. 4*a.* + 12*a.*) or R9 = charge on 6 md. ; $\therefore$ 12*a.* = charge on $\frac{1}{2}$ md. Therefore $\frac{1}{2}$ md. is allowed free.

Example 14. Two guns are fired from the same place after an interval of 6 minutes, but a person approaching the place observes that 5 min. 51 sec. elapse between the reports ; what was his rate of progress, sound travelling 1125 ft. per second ?

In 5 min. 51 sec. or 351 sec. the man travels a distance which sound will travel in (6 min − 5 min. 51 sec.) or 9 sec. But in 9 sec. sound travels 1125×9 ft.; $\therefore$ in 351 sec. the man travels 1125×9 ft.; $\therefore$ in 1 hour the man travels $\frac{1125 \times 9 \times 60 \times 60}{351 \times 3 \times 1760}$ miles or $19\frac{191}{286}$ miles.

Example 15. R49 was divided amongst 150 children, each girl had 8*a.* and each boy 4*a.* ; how many boys were there ?

If 4*a.* be given to each child, R37. 8*a.* will be spent, and the boys will have got their shares. The remaining sum, R11. 8*a.*, must therefore be distributed amongst the girls only, giving 4*a.* to each. Hence the number of girls is the same as the *number of times* 4*a.* is contained in R11. 8*a.* ; therefore the number of girls is 46, and therefore the number of boys is 104.

This example may also be solved by the method of Art. 225. Thus : When R49 is divided amongst 150 children, each gets $\frac{392}{75}a.$ on the average. Hence the question may be put thus—"Each boy is to have $4a.$ and each girl $8a.$; in what ratio should they be mixed that each may have $\frac{392}{75}a.$ on the average ?" Therefore by the method of Art. 225 we find that the ratio of the number of boys to the number of girls must be $(8-\frac{392}{75}) : (\frac{392}{75}-4)$ or $104 : 46$ But $104+46=150$; $\therefore$ the number of boys $=104$, and the number of girls $=46$.

Example 16. A free-hold estate is bought at 20 years' purchase ; find the rate of interest obtained on the money invested

["A free-hold estate is bought at 20 years' purchase" means that it is bought for 20 times the yearly rent derived from the estate]

If the value of the estate is R20, the rent is R1 ; $\therefore$ if the value of the estate is R100, the rent is R5. Therefore the rate of interest obtained is 5 p. c.

Example 17. If 36 oxen in four weeks eat up the grass on a field of 12 acres and what grows upon it during the time ; and 21 oxen eat up the same in 9 weeks ; how many oxen will it maintain for 18 weeks, supposing the grass to grow uniformly during the time ?

Origl. growth + 4 wk.'s growth maintains	36 ox. for	4 wk.	
$\therefore$	1 ox for	144 wk. ;	
also, origl. growth + 9 wk.'s growth............	21 ox. for	9 wk.,	
$\therefore$	1 ox for	189 wk.	

Hence, subtracting 2nd line from the 4th,

	5 wk.'s growth maintains	1 ox for	45 wk.,
$\therefore$	1 wk.'s growth	1 ox for	9 wk.,
$\therefore$	16 wk.'s growth	1 ox for	144 wk.,
but origl. growth +	4 wk.'s growth	1 ox for	144 wk. ;

$\therefore$ origl. growth = 12 wk.'s.

Now,	1 wk.'s growth maintains for	9 wk.	1 ox,
$\therefore$	1 wk.'s growth .... for	18 wk.	$\frac{1}{2}$ ox,
$\therefore$	30 wk.'s growth .... for	18 wk	15 ox ,
i.e., origl. growth +	18 wk.'s growth .... for	18 wk.	15 ox.

Answer. 15 oxen.

EXAMPLES. 172.

1.* A person has a number of oranges to dispose of ; he sells half of what he has and one more to *A*, half of the remainder and

one more to B, half of the remainder and one more to C, and half of the remainder and one more to D; by which time he has disposed of all he had. How many had he at first?

2. A thief having stolen some money from the palace of Siraj Uddowlah was caught on his way back by the head *khoja* who let him off on getting half the money and R20 more; he was caught again by the sentry at the palace gate, who got a third of what he then possessed and R10 more; lastly he was let off by the *kotwal* in his rounds on getting $\frac{1}{4}$ of what he still had and R6 more. The theif came home robbed of all he stole. How much did he steal?

3. The expenses of a family, when rice is at 8 seers for a rupee, are R75 a month; when rice is at 10 seers for a rupee, the expenses are R72 a month (other expenses remaining unaltered): what will they be when rice is at 12 seers for a rupee?

4. A labourer was engaged for 15 days, on the agreement that for every day he worked he should have 6*a*., but that for every day he absented himself he would be fined 2*a*. He received R4. 2*a*. at the end of the time . how many days was he absent?

5. I have to be at a certain place in a certain time, and I find that if I walk 3 miles an hour I shall be 10 min. too late, and if I walk 4 miles an hour I shall be $7\frac{1}{2}$ min. too soon: what distance have I to go?

6. I have a certain sum of money to be distributed among a certain number of boys, and I find that if I give R2 to each I shall spend R4 too little. but if I give R3 to each I shall spend R3 too much. How much have I to spend?

7. I have a certain sum of money wherewith to buy a certain number of nuts, and I find that if I buy at the rate of 40 a penny I shall spend 5*d*. too much, if 50 a penny, 10*d*. too little. How much have I to spend?

8. A lb. of tea and 3 lb. of coffee cost 5*s*.; but. if coffee were to rise $33\frac{1}{3}$ p. c. and tea 50 p. c., they would cost 7*s*. Find the cost of tea and coffee per lb.

9. 3 lb. of tea and 4 lb of sugar cost 8*s*.; but, if sugar were to rise 25 p. c. and tea were to fall 25 p. c., they would cost 7*s*. Find the cost of tea and sugar per lb.

10. Three tramps meet together for a meal; the first has 3 loaves, the second 4, and the third, who has his share of the bread, pays the other two 7 half-pence; how ought they to divide the money?

11. Two settlers in New Zealand own adjoining farms of 700 and 500 acres respectively. They unite their farms, taking at the same time a new partner who pays £1200 on the understanding that $\frac{1}{3}$ of the land will in future belong to each. How is the £1200 to be divided between the original owners?

12. The sum of the ages of *A*, *B* and *C* is now 90 years, and their ages 10 years ago were as 3 : 4 : 5 ; find their present ages.

13. *A* is twice as old as *B*, and 5 years older than *C* ; the sum of their ages is 45 years : find the age of each.

14. Divide ₨80 between *A*, *B* and *C* in such a manner that *A* may get 3 times as much as *B*, and *B* ₨10 more than *C*.

15. *A* and *B* begin business with equal capitals. At the end of the year *A* has gained ₨130, and *B* has lost $\frac{1}{10}$ of his capital ; *A* has then twice as much as *B*. Find how much each had at first.

16. *A* and *B* begin business with equal capitals. At the end of a certain time *A* has gained $\frac{1}{4}$ of his capital, and *B* has lost ₨200 ; *B* has now [illegible] of what *A* has. How much had each at first ?

17. Divide 155 into two parts such that, twice the first part and 3 times the second part may be together equal to 370.

18. Divide 100 into two parts such that, $\frac{1}{5}$ of one part and $\frac{1}{3}$ of the other part may be together equal to 40.

19 Divide 350 into two parts such that, 3 times the first part and $\frac{1}{3}$ of the second part may be together equal to 250.

20. Mangoes are bought at ₨5 per 100 ; at what rate per 100 must they be sold that the gain on ₨100 may be equal to the selling price of 400 mangoes ?

21. Sugar is bought at 4*a*. per seer ; at what rate per seer must it be sold that the gain on ₨10 may be equal to the selling price of 8 seers ?

22. Two passengers going to the same place had 8 md. of luggage between them, and were charged for excess of luggage ₨8 and ₨4 respectively ; had the luggage all belonged to one person he would have been charged ₨14 for excess. Find how much is allowed free, and how much luggage each had.

23. Two guns are fired from the same place after an interval of 10 minutes, but a person approaching the place observes that 9 min. 30 sec. elapse between the reports ; what was this rate of progress, sound travelling 1121 ft. per second ?

24. Two guns are fired from the same place at an interval of 15 minutes, but a person going away from the place hears the reports at an interval of 15 min. 30 sec. ; if sound travels 1125 ft. per second, find his rate of travelling per hour.

25. Two guns are fired from a place at an interval of 28 minutes, but a person approaching the place, at the rate of $13\frac{7}{11}$ miles an hour, hears the reports at an interval of 27 min. 30 sec. Find the velocity of sound per second.

26. Cannons are fired at regular intervals in a town, and a person riding towards it at the rate of 9 miles an hour hears the

reports at invervals of 15 minutes; at what intervals must the cannons have been fired, sound travelling 1120 ft. per second?

27. Cannons are fired at intervals of 10 minutes in a town towards which a passenger train is approaching at the rate of 30 miles an hour; if sound travels 1136 ft. per second, find at what intervals the reports will be heard by the passengers.

28. Rs.60 was distributed among 50 children, each girl had Rs.2 and each boy Rs.1; how many boys were there?

29. 35 fruits, consisting of mangoes and oranges, were bought for Rs.2. 8a.; if the mangoes cost 2a. each and the oranges 6p. each, find the number of oranges bought.

30 A lumb composed of gold and silver measures 6 cu. inches and weighs 100 oz.; if a cu. inch of gold weighs 20 oz. and an equal bulk of silver 12 oz, find the weight of gold in the mixture.

31. 19 grains of gold or 12 grains of silver displace one grain of water. If a ring, composed of gold and silver, weighs 88 grains and displaces 5 grains of water, how many grains of silver does it contain?

32. A farmer has oxen worth £12. 10s. each, and sheep worth £2. 5s. each; the number of oxen and sheep being 35, and their value £191. 10s. Find the number he had of each

33. If an income-tax of 7d in the £ on all incomes below £100 a year, and of 1s. in the £ on all incomes above £100 a year realises £18750 on £500000, how much is raised on incomes below £100 a year?

34. How many years' purchase should be given for a free-hold estate so as to get 5 per cent. for the money?

35. An estate is bought at 25 years' purchase for Rs.40,000, one fourth of the purchase-money remaining at mortgage at 6 per cent. The cost of collecting rents is Rs.100 per annum. What interest does the purchaser make on his investment?

36 If 10 oxen in 5 weeks eat up the grass on a field of 7 acres and what grows upon it during the time, and 11 oxen eat up the same in 4 weeks, how many weeks' growth is on the field?

37. If 20 oxen in 4 weeks eat up the grass on a field of 4 acres and what grows upon it during the time; and 17 oxen eat up the same in 10 weeks; how many oxen will it maintain for 5 weeks, supposing the grass to grow uniformly during the time?

38. In a certain meadow there is a crop of 525 stones of grass, which grows uniformly. If 11 oxen turned in would consume all the grass in 48 days, but 6 oxen would require 98 days, what weight of grass would each ox eat in a day?

39. If 25 horses eat the grass of 35 acres of one field in 11

days, in what time would 20 horses eat the grass of another field of 56 acres, where there is at first twice as much grass per acre as in the former field, the growth of the grass being neglected? What must be the ratio of the rates of the growth of the grass in the two fields so that your result may be accurately true?

40. A well is fed by a spring which flows continuously and uniformly into it. When there are 10,000 cu. ft. of water in the well, 7 men can empty it in 20 days; and when there are 15,000 cu. ft. of water in the well, 5 men can empty it in 50 days. How many cu. ft. of water flow into the well in one day?

41. A cistern has one supply-pipe (*A*) and 2 equal waste-pipes (*B*, *C*) attached to it. *A* is opened, and when the cistern is partially filled *B* is also opened, and the cistern is emptied in 3 hours. Had *C* been opened along with *B* the cistern would have been emptied in 1 hour. How long after *A* was *B* opened?

42 A cistern has two pipes attached to it, one to supply and one to draw off. If both the pipes are opened together, the cistern is filled in 9 hours; but if the waste-pipe is opened one hour after the supply-pipe, the cistern is filled in 7 hours. In what time can the supply-pipe fill the empty cistern?

43 A leaky cistern is filled in 5 hours with 30 pails of 3 gallons each, but in 3 hours with 20 pails of 4 gallons each, the pails being poured in at intervals. Find how much the cistern holds, and in what time the water would waste away.

EXAMPLES FOR EXERCISE. 174a.

(First Series.)

1. State in words 10030200720021.

2. Find the value of $66674 - 9645 - 201 + 843 - 8761$.

3. Reduce £49. 6*s*. $2\frac{1}{4}$*d*. to farthings.

4. Find the prime factors of 51425.

5. Reduce $\frac{18677}{20008}$ to its lowest terms.

6. Find the sum and difference of 23·001 and ·0414.

7. Find the value of $\frac{3}{8}$ of R7. 7*a*. 7*p*.

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8. Write in words 3200103102 according to the Indian numeration

9. The greatest prime number known is expressed by $1251^2 + 2920^2$; find this number.

10. What sum will remain when four bills, amounting to R5. 7. 6, R3. 4. 9, R2. 15. 3, and R10. 13. 3 respectively, have been paid out of R25?

11. Find the G. C. M. of 23791 and 8029.

12. Subtract $14\frac{5}{140}$ from $16\frac{4}{35}$.

13. Multiply ·038 by ·0042, and divide ·03217 by 6·25.

14. Find the value of ·00625 of £1.

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15. Subtract one crore five lacs three thousand and twenty from twenty-nine million twelve thousand and four.

16. Multiply 765389 by 641·64 in 3 lines.

17. I go to town with £9. 1*s.* 3*d.* What have I left after buying a dozen chairs at 13*s.* $7\frac{1}{2}$*d.* each?

18. Find the L. C. M. of 9669 and 16115.

19. Add together $\frac{14}{17}$, $3\frac{1}{9}$, $1\frac{5}{81}$ and $\frac{5}{27}$.

20. Express as a decimal $·0003+\frac{817}{3125}-·00849+\frac{381}{800}$.

21. Reduce $\frac{2}{9}$ of $\frac{5}{13}$ of 19*s.* 6*d.* to the fraction of $\frac{3}{5}$ of $\frac{4}{17}$ of £1. 8*s.* 4*d.*

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22. Express 944 in Roman notation, and CDXCIX in Arabic notation.

23. Multiply 387659 by 85672 in 3 lines.

24. How many cows at R10. 14*a.* each can I buy with the proceeds of selling 87 horses at R115. 2*a.* each?

25. Simplify $\dfrac{6\frac{3}{4}-1\frac{5}{11}}{2\frac{1}{6}+1\frac{2}{7}}$.

26. Multiply ·006134 by 80·032, and divide the result by ·0032.

27. Reduce $(8\div1\frac{1}{4})$ of 1*p.* to the decimal of R1. 4*a.*

28. If a rupee is worth 2*s.* $0\frac{3}{8}$*d.*, and a dollar 4*s.* $4\frac{3}{8}$*d.*, find the least number of rupees which makes an exact number of dollars.

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29. What number multiplied by 76 will give the same product as 153 multiplied by 380?

30. Find the greatest number which will divide each of 3456, 26244 and 99225 without remainder.

31. Reduce 57 tons 9 cwt. 1 qr. 10 lb. to drams.

32. Simplify $\frac{3}{4}\times\frac{5}{8}\div1\frac{1}{3}$ of $1\frac{1}{2}$.

33. Find the least fraction which being added to $\frac{1}{3}-\frac{1}{4}$ of $\frac{1}{5}-\frac{1}{6}$ will make the sum an integer.

34. *A* did ·0025 of a piece of work, and *B* ·7855. How much was left undone?

35. Find the cost of 3·125 yards at £·375 a yard.

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36. What number is the same multiple of 35 that 3456 is of 9?

37. If my income is R3500 and I save R507 a year, what is my average daily expenditure?

38. Simplify $\dfrac{(\frac{1}{6}-\frac{1}{8}) \text{ of } (\frac{1}{8}-\frac{1}{9})}{\frac{1}{2}-\frac{1}{3} \text{ of } \frac{1}{8}-\frac{1}{9}}$.

39. If the sum of $21\frac{5}{7}$ and $3\frac{6}{11}$ be added to the product of $2\frac{1}{4}$ and $\frac{7}{8}$, by how much will the result differ from 28?

40. Reduce $3\frac{17}{247}$ to a decimal.

41. Find the vulgar fraction equal to $\cdot 27\dot{8}9\dot{9}$.

42. Find the value of $\frac{3}{8}$ of R3 . 7 . 6 + ·375 of R6 . 8 . 6.

43. Find the least number which being subtracted from 97856 will make the result divisible by 141.

44. Reduce 3 acres 1 rood 2 perches to square feet.

45. Arrange $\frac{2}{5}$, $\frac{3}{7}$, $\frac{27}{70}$ in order of magnitude.

46. Divide $\frac{2}{3} \div \frac{3}{4}$ of 12 by $\frac{2}{3}$ of $\frac{3}{4} \div 12$.

47. Add $3\cdot 7\dot{2}\dot{5} + \cdot 00\dot{2} + \cdot 27\dot{2}\dot{5}$.

48. Reduce $\cdot 0\dot{3}$ of R3 to the decimal of $\frac{3}{4}$ of R1·5.

49. Find the least number of weeks in which an exact number of half-guineas can be earned, the wages per week being 7·5 shillings.

50. What is the least number which being added to 30321 will make the sum divisible by 681?

51. A bill of £6. 1*s.* 11*d.* has to be paid by several persons in equal shares; if three of them together pay £1. 13*s.* 3*d.*, how many are there to share the cost?

52. Simplify $2\frac{10}{17} \times 1\frac{33}{35} \div \frac{87}{28} \times 2\frac{13}{66}$.

53. Divide 352·95624 by ·000504.

54. Express $1\cdot 4 \div 1\cdot \dot{1}\dot{3}$ as a decimal.

55. Reduce ·543 of 19*s.* $3\frac{1}{4}$*d.* to pence.

56. Find the greatest unit of time by means of which 2 hr. 3 min. and 1 hr. 4 min. 30 sec. can both be expressed as integers.

57. I multiply a number by 36 and divide the result by 12 and obtain 374181 as quotient. What was the number?

58. *A* and *B* together have R36. 13*a.* 9*p.*, and *A* has R3. 3*a.* 3*p.* more than *B*; find how much *B* has.

59. Reduce $\frac{4184}{19008}$ to its lowest terms.

60. Express $3\frac{19}{22}$ poles in poles, yards, etc.

61. What are the nearest integers to $8\frac{9}{16}$ and $7\frac{5}{11}$?

62. Find the difference between the product and quotient of $5\cdot312$ by $\cdot0125$.

63. Simplify $(2\cdot3\dot{6}\dot{4} - 1\cdot\dot{6}9\dot{7}) + 1\cdot\dot{3} \times (2\cdot\dot{4} + 7\cdot\dot{5})$.

64. If in a division sum the divisor be 7 times and the quotient 5 times the remainder, what is the dividend when the remainder is 360 ?

65. Reduce 300,003,840 grains to pounds Troy.

66. Find the cost of 13724 articles at Rs. 0*a*. $7\frac{1}{2}$*p*. each.

67. Multiply $7\frac{1}{6} + 6\frac{2}{3}$ by $2\frac{1}{13} - \frac{23}{52}$.

68. What fraction of a journey of 15 miles have I gone on reaching a place $6\frac{3}{5}$ miles distant ?

69. By what must $1550\frac{13}{16}$ be divided that the quotient may be $459\frac{1}{2}$?

70. If a metre be 39·37 inches, how many metres make 3 miles ?

71. When 2080400 is divided by a certain number, the quotient is 381 and the remainder 1664. What is the number ?

72. Reduce 67501 inches to poles, etc.

73. If $7\frac{1}{15}$ tons cost R964. 3*a*. 8*p*., what is the cost of 1 ton ?

74. Simplify $\dfrac{3-4\frac{1}{7}+2\frac{1}{3}}{3\times2\frac{1}{3}-4\frac{1}{7}} \div \dfrac{6\frac{1}{4}\text{ of }4\frac{4}{5}}{11\frac{1}{3}-6\frac{7}{10}}$.

75. Divide equally amongst 5 boys $\frac{5}{7}$ of £4. 2*s*. $1\frac{3}{4}$*d*.

76. Divide ·7029 by ·0165.

77. What decimal of R3. 7*a*. must be taken from R4. 15*a*. to leave R2·5 ?

78. If when a number is divided continuously by 5, 6 and 7, the remainders are 2, 3 and 4 respectively, what would be the remainder if the number were divided by 210 ?

79. If 1 md. cost R11. 1*a*., find the cost of $\frac{70}{131}$ of a md.

80. The 1st of January 1893 was on a Sunday ; on what day of the week will 10th February fall in the year 1894 ?

81. Find the value of $\dfrac{7\frac{4}{11}}{8\frac{2}{3}} \div \dfrac{2\frac{5}{7}}{7\frac{1}{2}}$ of $\dfrac{8\frac{4}{11}}{5\frac{1}{3}}$.

82. *If from a rope 7 ft. long as many pieces as possible are cut off, each $1\frac{2}{3}$ ft. long, what fraction of the whole will be left ?*

83. Reduce $\cdot\dot{1}4285\dot{7}+\cdot\dot{8}5714\dot{2}-\cdot\dot{2}8571\dot{4}$ to a vulgar fraction.

84. Simplify $\frac{1\cdot5}{\cdot075}\times\frac{3\cdot25}{1}$.

85. Find a number such that if it be added 35 times to 25 the sum will be 25540.

86. If a person spends in 4 months as much as he earns in 3, how much can he lay by annually, supposing that he earns £250. 10*s*. every 6 months ?

87. Simplify $\frac{(3\frac{1}{4}-2\frac{1}{2})\div\frac{5}{8}\text{ of }\frac{3}{8}}{2\frac{2}{3}\div(\frac{1}{2}+\frac{1}{4})}$.

88. How many steps does a man whose length of pace is 32 inches take in $4\frac{3}{4}$ miles ?

89. Divide ·75445 by ·00625.

90. How many inches are there in ·1215625 of a mile ?

91. Subtract ·432 of an acre from $2\frac{1}{2}$ roods, expressing the result in sq. yards and the decimal of a sq. yard.

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92. A man buys 100 md. of rice ; he loses as much by selling 60 md. at R3 a md. as he gains by selling the rest at R4. 4*a*. a md. Find the cost price of a md.

93. By what prime numbers may 109 be divided so that the remainder may be 4 ?

94. Add $\frac{8478}{8516}+\frac{4247}{4416}+\frac{4831}{5530}$.

95. How many times can ·053 be subtracted from 14·578, and what will be the magnitude of the remainder ?

96. Express $\cdot2\dot{3}\dot{6}$ of 4*a*. 7*p* + $\cdot51\dot{6}$ of 10*a*. as the decimal of R1. 4*a*.

97. Simplify $\frac{(3\cdot2-2\cdot9)\times147}{\cdot003\times\cdot0005}$.

98. Three bells toll at intervals of 1·2, 1·8 and 2·7 seconds respectively, beginning together ; how often will each toll before their tolling together again ?

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99. The remainder after a division is 97, the quotient is 521, and the divisor is 9 more than the sum of both ; what is the dividend ?

100. Two pieces of cloth of the same length cost £5. 11*s*. 9*d*. and £7. 4*s*. respectively ; the price of the first was 3*s*. $1\frac{1}{3}$*d*. per yard : what was the price of the second per yard ?

101. Divide $\frac{1}{2}$ of $\frac{3}{5}$ of $\frac{5}{7}$ of 42 by the sum of $2\frac{1}{3}$ and $4\frac{5}{8}$.

102. Simplify $\frac{1}{2}[2-\frac{1}{2}\{2-\frac{1}{2}(2-\frac{1}{2})\}]$.

103. Reduce $\frac{29}{56}$ to a decimal.

104. Multiply 28·8 by 25·3 and divide the product by 6·48.

105. The distance between two wickets was marked out for 22 yd., but the yard measure was $\frac{5}{12}$ of an inch too short: what was the actual distance?

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106. If a number of articles at ₨4. 0*a*. $5\frac{1}{4}$*p*. each cost ₨7059. 14*a*. $11\frac{1}{4}$*p*, how many are there?

107. Simplify $\dfrac{\frac{1}{2}-\frac{1}{3}}{\frac{1}{2}+\frac{1}{3}}$ of $\dfrac{\frac{1}{4}-\frac{1}{5}}{\frac{1}{4}+\frac{1}{5}}$ of $\dfrac{\frac{1}{6}-\frac{1}{7}}{\frac{1}{6}+\frac{1}{7}}$ of 117.

108. Find the value of $\dfrac{\cdot426\times\cdot426-\cdot174\times\cdot174}{\cdot426-\cdot174}$ of ₨1. 4*a*.

109. Subtract 5·142857 from $5\cdot\dot{1}4285\dot{7}$.

110. Divide 1·00625 by 132·5 to five places of decimals.

111. Reduce 4 hr. 48 min. to the decimal of 6 hr.

112. A man owns $\frac{7}{18}$ of a house, and sells $\cdot1\dot{3}5\dot{1}$ of his share; what fraction of the house does he still own?

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113. How many revolutions will be made by a wheel, which revolves at the rate of 213 revolutions in 3 min., while another wheel revolving 374 times in 11 min. makes 544 revolutions?

114. Multiply 10 sq. yd. 4 ft. 76 in by 132.

115. Reduce to its lowest terms $\frac{285714}{714285}$.

116. Find the least number which, when divided by each of $\frac{7}{12}$, ·25, and $\cdot0\dot{3}$, gives a whole number as quotient in each case.

117. Simplify $\dfrac{5\cdot3\dot{4}\times5\cdot3\dot{4}-2\cdot6\dot{5}\times2\cdot6\dot{5}}{5\cdot3\dot{4}-2\cdot6\dot{5}}$.

118. Find, to the nearest pie, the value of ·1234 of ₨12·5.

119. A kilolitre contains 35·32 cubic feet, and a gallon contains 277·274 cubic inches; find to the nearest integer the number of gallons in a kilolitre.

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120. A farmer has 899 sheep and 493 lambs. He forms them into flocks, keeping sheep and lambs separate, and having the same number of animals in each flock. If these flocks are as large as possible, how many flocks will there be altogether?

121. If 257 pounds of tea cost £34. 16*s*. $7\frac{1}{4}$*d*., find the price of a pound to the nearest farthing.

122. Simplify $\dfrac{\frac{1}{2}\div\frac{1}{3}}{\frac{1}{4}\div\frac{1}{5}}\div\dfrac{\frac{1}{6}\div\frac{1}{7}}{\frac{1}{8}\div\frac{1}{9}}$.

123. How many whole cakes will be required for 50 children if each is to have $2\frac{4}{7}$ of $1\frac{4}{11}$ of $2\frac{3}{8}$ of $\frac{4}{9}$ of $\frac{1}{18}$ of $\frac{1}{10}$ of a cake ?

124. Find the value of $\dfrac{\frac{3}{8}\text{ of }\cdot375-\frac{2}{45}\text{ of }\cdot0\dot{4}}{\cdot375+\cdot0\dot{4}}$.

125. Find the circulating decimal which will become 2 when multiplied by $2\frac{3}{8}\div4\cdot5$.

126. A German mark is worth £·04895 ; find to the nearest farthing the value of 3725·39 marks.

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127. To a certain number I add 2, I multiply the sum by 4, I divide the product by 3, and I take 3 from the quotient ; the remainder is 17. What is the number ?

128. On what day of the week will Feb. 10 fall in the year 1960 ?

129. Find the greatest prime number which used as divisor of 12260 will leave remainder 17.

130. Find the value of $\dfrac{2\cdot8}{21}$ of $\dfrac{\text{R}1.\ 5a.\ 4p.}{\text{R}4.\ 2a.\ 8p.}$.

131. What is the number whose half exceeds its fifth part by 6 ?

132. Simplify $\cdot\dot{4}2857\dot{1}\times\cdot49\times\cdot20\dot{5}71428\dot{8}$.

133. How many times does a carriage wheel, whose circumference is 17·125 feet, turn round in a distance of $12\cdot\dot{4}\dot{5}$ miles ?

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134. Determine the prime factors of 282660 and 40299. Hence deduce the G. C. M. and L. C. M. of these numbers.

135. Find the least integer which, when divided by $1\frac{5}{21}$ and $1\frac{6}{7}$, will give a whole number as quotient in each case.

136. Simplify $\frac{4}{7}$ of $\dfrac{6\frac{5}{13}}{3\frac{3}{4}}-\frac{1}{28}$ of $\dfrac{1\frac{2}{5}}{6\frac{2}{3}}+\frac{3}{5}(\frac{3}{4}\times\frac{1}{5}+\frac{2}{3}\div\frac{2}{3})$.

137. Reduce $\frac{5}{99}+\frac{7}{990}+\frac{13}{99900}$ to a decimal.

138. If a cu. yd. of clay make 460 bricks, each $101\frac{1}{4}$ cu. in. how much does clay contract in baking ?

139. Multiply 324·567 by 13·212 in 2 lines.

140. One pendulum oscillates 6 times in 3·2 seconds, and another pendulum 8 times in 3·6 seconds ; if started simultaneously how often will they tick together in an hour ?

EXAMPLES FOR EXERCISE. 174b.

(Second Series.)

1. Write down the greatest and least numbers of four digits that you can form with the figures, 3, 0, 2, 1.

2. Simplify $\frac{1}{3}[3+\frac{1}{3}\{3+\frac{1}{3}(3+1\frac{1}{2})\}]\div\frac{1}{3}$.

3. The telegraph posts on a railway line are 66 yards apart; find the smallest number of miles that corresponds to an exact number of posts

4. A bath is supplied with water from two pipes, one of which can fill it in $12\frac{1}{3}$ min., the other in 15 min; there is also a discharging pipe which would empty it, when filled, in 10 min. The first pipe is open alone for 4 min., and then the first and second open together for 1 min.; if now the third pipe is opened as well, how long will it take to fill the bath?

5. The wages of *A* and *B* together for 20 days amount to the same sum as the wages of *A* alone for 35 days. For how many days will this sum pay the wages of *B* alone?

6. A cask contains 5 parts wine and 3 parts water; how much of the mixture must be drawn off and water substituted in order that the resulting mixture may be half and half?

7. A person borrows £130 on the 5th of March, and pays back £133. 18*s*. on the 10th October; find the rate of interest charged.

8. The digits in the units' and lacs' places of a number are 3 and 8 respectively; what will be the digits in the same places in the remainder when 99999 is subtracted from the number?

9. A whole number diminished by $\frac{1}{7}$ of itself, when divided by 307 gives a quotient 12 and a remainder 96; what is the number?

10. The length of a rectangular tennis-court is 5 yards longer than its breadth, and its perimeter is 130 yards; find its area.

11. The train which leaves Calcutta at 4-30 P. M. arrives at Burdwan at 8 P. M.; and the train which leaves Burdwan at 4-50 P. M. arrives in Calcutta at 8-30 P. M.: when do they pass each other?

12. The rent of a farm consists of a fixed sum of money together with the value of a certain number of maunds of wheat; when wheat is ₨2 a md. the rent is ₨40; when wheat is ₨2. 4*a*. a md. the rent is ₨42. 8*a*. What will be the rent when wheat is ₨2. 10*a*. a md.?

13. Assuming that the circumference of a circle is to its diameter as 22 is to 7, and that the circumference of the earth is to its diameter as 160 metres to 167 feet, determine to 4 places of decimals the ratio of a metre to a foot.

14. The interest on a given sum of money for one year is £5. 8*s*. 4*d*., the compound interest for two years is £11. 1*s*. Find the rate per cent.

15. If when a number is divided continually by 5, 6 and 8 the remainders are 2, 3 and 4 respectively, what would be the remainder if the same number were divided by 240?

16. Divide 1255 by 1·004, and hence deduce the quotient of 12·55 by 1004 and ·01255 by 1004000.

17. I bought a certain number of chairs for R45; also a certain number for R28 2*a*. at the same rate: find the greatest possible price of each chair.

18. A clock which gains $2\frac{1}{4}$ min. in a day, is 3 min. slow at noon on Sunday; when will it show correct time, and what time will it indicate at 6 on Monday evening?

19. A person bought 4 railway tickets to go 60 miles. Two were for the 1st class, one for the 2nd, and the fourth a half first class ticket, for a child. The cost of a 2nd class ticket was $\frac{2}{3}$ of that of a first class, and the whole sum paid was £1 . 11 . 8. Find the price of each ticket, and the rate per mile for the first class.

20. There are two mixtures of wine and water, in the ratios of 3 : 2 and 4 : 5 respectively; if one gallon of the first be mixed with 2 gallons of the second, what fraction of the resulting mixture will be wine?

21. A book sent from England costs me (including 1*s*. 6*d*. postage) 16*s*. 6*d*., my book-seller allowing me two pence in the shilling discount on the published price. What is the published price?

22. What number is the same multiple of 7 that 3975 is of 15?

23. Simplify $\frac{1}{7\frac{1}{4}+6\frac{6}{11}} \div \left(\frac{3}{13}-\frac{2}{9}\right) - \left(\frac{13}{3}+\frac{1}{6}\right) \div \frac{2}{3}$ of $\frac{3}{8}$ of 63.

24. On laying down a bowling-green with sods 2 ft. by 9 in., it is found that it requires 120 sods to form one strip extending the whole length of the green, and that a man can lay down one strip and a half each day; find the space laid down by 5 men in 2 days.

25. *A* can do a piece of work in 3 days, *B* can do 3 times as much in 8 days, and *C* 5 times as much in 12 days. In what time will they do it together, supposing them to work at the rate of 9 hours a day?

26. A farmer pays a corn-rent of 5 quarters of wheat and 3 quarters of barley, Winchester measure; what is the money value of his rent, when wheat is at 60*s*., and barley at 54*s*. per quarter, Imperial measure; 32 Imperial gallons being equal to 33 Winchester gallons?

27. Six coins of equal weight, made of gold and silver mixed, were melted together and re-cast. In one the gold and silver were in the ratio of 2 : 3; in two others, of 3 : 5; and in the rest, of 5 : 4. In what ratio will the gold and silver be mixed in the new coins?

28. A tradesman, selling goods for a certain price to be paid six months hence, offers to give one-tenth more of the same goods for the same price in ready money. What is the rate of discount?

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29. Find the greatest and least numbers of 6 digits which are exactly divisible by 239.

30. There is a number, to which 3 is added and $\frac{1}{10}$ of the result taken; to this 5 is added and $\frac{1}{15}$ of the result taken, giving $1\frac{1}{3}$: what is the number?

31. Find all the numbers of 5 digits divisible by 9, which have unity for their first and last digits and 2 for their middle digit. State the principle upon which you proceed.

32. On a stream, *B* is intermediate to and equidistant from *A* and *C*; a boat can go from *A* to *B* and back again in 5 hr. 15 min., and from *A* to *C* in 7 hr. How long would it take to go from *C* to *A*?

33. If the price of bricks depends upon their magnitude, and if 100 bricks, of which the length, breadth and thickness are 16, 10 and 8 inches respectively, cost R2. 9*a*., what will be the price of 921600 bricks which are one-fourth less in every dimension?

34. There are two mixtures of wine and water, the quantities of wine in them being respectively ·25 and ·75 of the mixtures. If 2 gallons of the first be mixed with 3 gallons of the second, what will be the ratio of wine to water in the compound?

35. How much per cent. must be added to the cost price of goods that a profit of 20 per cent. may be made after throwing off a discount of 10 per cent. from the labelled price?

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36. Determine the least number, by which 616 must be multiplied so as to produce a number exactly divisible by 770.

37. Multiply the sum of $2\cdot\dot{4}$ and $7\cdot\dot{5}$ by $1\cdot\dot{3}$, and add the result to the difference of $2\cdot3\dot{6}\dot{4}$ and $1\cdot\dot{6}9\dot{7}$.

38. The floor of a room is 50 ft. long and 40 ft. wide. Find the cost of supplying it with carpet, 2 ft. wide, at R3 per yard, and oil-cloth, 2 yards wide, at R1 per yard; the oil-cloth to be laid along the sides and ends a yard and a half wide, and the carpet to extend one foot over the oil-cloth everywhere.

39. On a certain evening half an hour after sunset a watch was set at 12 o'clock. The morning following it was 8 minutes

past 4 by a common clock when it was 4 minutes past 8 by this watch. Find the time of sunset the previous evening.

40. *A* has shares in an estate to the amount of $(\cdot 15 \div \cdot \dot{3}6)$ of it. *B* has shares in the same estate to the amount of $\cdot 4\dot{7}\dot{2}$ of it. Find the difference in value between the properties of *A* and *B*, when $\cdot 0\dot{5}\dot{6}$ of the estate is worth £373·3

41. Three equal glasses are filled with mixtures of spirit and water: the proportion of spirit to water in each glass is as follows: in the first glass as 2 : 3, in the second glass as 3 : 4, and in the third as 4 : 5. The contents of the three glasses are emptied into a single vessel; what is the proportion of spirit and water in it?

42. If the true discount on a bill of £14641 be £4641 at 10 per cent. compound interest, how many years has the bill to run?

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43. Twenty-fifth part of a certain number is equal to the seventh part of 42; what is the number?

44. Simplify $\frac{21}{122}(4\frac{1}{8} \text{ of } 6\frac{2}{7} + \frac{3}{14}) \div 4\frac{1}{8} \text{ of } (6\frac{2}{7} + \frac{3}{14})$.

45. A company of Sepoys proceed in 5 equal rows, and after sometime arrange themselves into 7 equal rows. Find the least number above 1000, which the company may contain.

46. *A* is twice and *B* is just as good a workman as *C*. The three work together for two days, and then *A* works alone for half a day, and *B* for a day. How long would it have taken *A* and *C* together to complete as much as the three will have thus performed?

47. A steam-ship whose speed averages 14 miles an hour, reaches a certain port in 12 days; how many days afterwards will a sailing vessel arrive, which started at the same time and sailed on an average 8 miles an hour?

48. From a cask of wine $\frac{1}{5}$ is drawn off and the cask is filled up with water; $\frac{1}{5}$ of the mixture is then drawn off and the cask is again filled up with water; after this process has been repeated 4 times, what will be the ratio of wine to water in the resulting mixture?

49. The sum of £2100 is due in 4 years, but it is paid by instalments as follows:—£275 at the end of 2 years, £460 at the end of the 3rd year, £500 at the end of the 4th year, and £600 at the end of the 5th year. What amount should be paid at the end of the 6th year, in order to clear off the balance, simple interest being reckoned at the rate of 5 per cent. per annum?

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50. Twenty times a certain number is equal to 7 times 40; what is the number?

51. What is the least number of shot, each $1\frac{1}{4}$ oz., that will weigh an integral number of pounds?

52. A *rod of brick work* contains 306 cu. ft.; find the cost of building a brick wall, 68 yd. by 6 ft. by 2 ft. 2 in., at ₨18 per rod.

53. How long would a column of men, extending 3420 feet in length, take to march through a street, a mile long, at the rate of 58 paces in a minute, each pace being $2\frac{1}{2}$ feet?

54. 195 men are employed to work on a railway embankment, $1\frac{1}{2}$ miles long, which they are expected to finish in 4 weeks. But at the end of 1 week it is found that they have finished only 520 yards. How many more men must be engaged to finish it in the required time?

55. *A* is a cask containing 125 gallons of wine; *B* is another cask containing 175 gallons of water. 100 gallons are drawn from each, mixed together, and the casks are refilled with the mixture. This operation is once more repeated. Find the ratio of wine to water in each cask now.

56. A person who pays 5*d.* in the £ income-tax finds that a rise of interest from 6 to $6\frac{1}{2}$ per cent. increases his income by £23. 10*s.* What is his capital?

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57. From a certain number I take 320; to the remainder I add 24; I multiply the sum by 8, and find that the product is equal to the sum of 304 and 760: what is the number?

58. What decimal of 2·25 units is ·05 of a unit?

59. A jar can be exactly filled by glasses holding 3 pints each; it can be exactly emptied again by glasses holding 5 pints each; given that the capacity of the vessel is between 11 and 12 gallons, find the exact capacity.

60. Two clocks are set right at noon on Monday. One loses and the other gains 1 min. a day. What time will be indicated by the latter, when the former points 10 h. $49\frac{1}{11}$ m. P. M. on the following Saturday?

61. Three gardeners working all day can plant a field in 10 days, but one of them having other employment can work only half time. How long will it take them to complete the work?

62. One vessel contains 20 gallons of wine; another contains 20 gallons of water. One gallon is taken from each, and poured into the other. This is done 3 times. Find the strength of the two mixtures.

63. A gentleman bequeaths his property to his children to be so divided that their shares shall be equal on their coming to age at 21, counting interest and discount at 5 per cent. He dies worth £13240, leaving three children aged 23, 21 and 19 respectively. How much should each receive?

64. To a certain number I add 7, I multiply the sum by 5, I divide the product by 9, and take 3 from the quotient; the remainder is 12: what is the number?

65. Simplify $(\cdot 5+\cdot 75)(2\cdot 5-\cdot 4)\div\left(\cdot 125+\frac{1}{4\cdot 8}\right)$.

66. Find the weight in tons per sq. mile of a rain-fall of 7 inches, having given that a cu. ft. of water weighs 1000 oz.

67. A, B and C are employed on a piece of work. After 15 days A is discharged, $\frac{1}{3}$ of the work being done. B and C continue at the work, and after 20 days more B is discharged, $\frac{1}{3}$ more of the work being done. C finishes the work in 30 days. In what time would the work have been done, if A and B had continued to work?

68. If one man walks 165 miles in 6 days, how far will another man walk in 15 days, if the first man walks $3\frac{3}{4}$ miles in the same time that the other man takes to walk 4 miles?

69. If 3 cubic inches of iron and 2 cubic inches of water weigh as much as 2 cubic inches of iron and 9 cubic inches of water; find the ratio of the weight of a cubic inch of iron to that of a cubic inch of water.

70. I buy goods for R600, and sell them directly for R680, giving three months' credit; what is gained per cent. per annum?

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71. From the tenth part of a certain number I subtract 10, and find that the remainder is 10; what is the number?

72. $\frac{4}{5}$ of a number exceed the sum of its third and fourth parts by 26; what is the number?

73. Two cog-wheels, having 75 and 130 teeth respectively, are working together; after how many revolutions of the smaller wheel will the teeth which once touch, touch again?

74. A train leaves P for Q, at the same time that a train leaves Q for P; the trains meet at the end of 6 hours, the train from P to Q having travelled 8 miles an hour more than the other. Find the rates of the trains, the distance from P to Q being 162 miles.

75. If 1000 rupees a month be equivalent to £1112. 10s. a year, what is the value of a rupee in English money?

76. Divide £20 among 2 men, 3 women and 4 children, so that each woman gets twice as much as a child, and each man as much as a woman and a child together.

77. If the interest of £253. 2s. 6d. at 5 p. c. be equal to the discount on £257. 6s. 10½d. for the same time and at the same rate, when is the latter sum due?

78. Find a number such that if it be subtracted 25 times from 7201 the remainder will be 951.

79. How many parcels of gold dust, each weighing 17·36 grains, can be made up out of 1 lb. 2 oz. 1 dwt. 3 gr.; and how much will remain over?

80. A room is 20 ft. long, 15 ft. wide and 10 ft. high. There are in it 4 doors, each 7 ft. by 4 ft.; the fireplace is 6 ft. wide and 4 ft. high; a skirting 2 ft. deep runs round the walls. Find the expense of papering the room at 6 annas a sq. yd.

81. If the hands of a clock coincide every $65\frac{1}{2}$ min. (true time), how much does the clock gain or lose in a day?

82. *A* can copy a certain manuscript in 17 hours by writing at the rate of 3 lines per minute; *B* can copy the same in 24 hours. After 476 lines have been copied by *A*, in what time can *B* finish it?

83. A town contains 12 Hindus to every 3 Mahomedans and to every 3 Christians; if there are 4800 Hindus, find the number of Christians.

84. Two sums, each of £138. 2*s.* 6*d.*, being due, one at the present time and the other 12 months hence, how much ought to be paid 6 months hence to clear off both debts, interest being 4 p. c. per annum.

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85. The difference between two numbers is 375, and one of them is 7809; what is the other?

86. Simplify

$$\frac{1664}{1408} \text{ of } \left\{ \frac{7}{10} \text{ of } £3\tfrac{3}{14} + 6\tfrac{2}{3} \text{ of } £3.\ 0s.\ 9d. - 4\tfrac{3}{7} \text{ of } £3.\ 2s. \right\}.$$

87. A fruit-seller has 1134 mangoes and 630 oranges. He forms them into heaps keeping the mangoes and oranges separate, and having the same number of fruits in each heap. If these heaps are as large as possible, how many fruits are there in each?

88. A cistern, the cubic content of which is 360 cu. ft., has two pipes which can empty it in 3 and 4 hours respectively. It has also a third pipe with an orifice of 1 sq. ft., through which water flows into the cistern at the rate of 1 yd. per minute. If all the three pipes be opened together when the cistern is full, in what time will it be emptied?

89. If 4 men or 6 women can do a piece of work in 20 days, in what time will 3 men and 2 women do it? On what supposition will the numerator of the fraction in your answer represent the number of *hours* they worked on the day to which the fraction refers?

90. Divide £1140 among *A*, *B*, *C*, in such a way that *A* may get half as much again as *B*, and *B* half as much again as *C*.

91. A dealer buys 10 horses at R400 each, 8 horses at R500 each and 4 horses at R600 each. He keeps the horses for 6 months, during which time each costs R15 a month, and sells them clearing $12\frac{1}{2}$ p. c. on his original outlay after paying all his expenses. Find the average selling price of each horse.

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92. A carriage and a horse are together worth R1200 ; if the carriage is worth R200 more than the horse, how much is the horse worth?

93. The population of a town is 60,000 ; if the births are 1 in 20, and the deaths 1 in 30 annually, what will the population become in one year ?

94. A cistern, 9 ft. by 6 ft. by 5 ft., is emptied in 15 minutes by a pipe whose cross section is 36 sq. in. ; how fast does the water flow in the pipe ?

95. A race-course is $2\frac{1}{4}$ miles round. Four men start to walk round it. They walk at the rates of $3\frac{1}{4}$, $3\frac{3}{4}$, $4\frac{1}{2}$ and 5 miles per hour. How long will it be before they all meet again at the starting point ?

96. 40 lb. troy of standard gold, containing 11 parts in 12 of pure gold, is coined into 1869 sovereigns ; calculate in grains the weight of pure gold in a sovereign.

97. Divide R7. 5*a.* into two parts, one of which is $\frac{2}{3}$ of the other.

98. If mangoes be bought at the rate of 13 for a rupee, how must they be sold to gain 30 per cent. ?

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99. *A* has £324 ; *B* has £29 less than *A* ; and *C*, if he had £205 more than what he has, would have as much as the double of *A* and *B* together : how much has *C* ?

100. In how many years will the error amount to a day in considering the year to consist of $365\frac{1}{4}$ days instead of 365·242218 ?

101. The circumferences of two wheels measure 168 and 401 inches respectively ; find the largest cogs which can be cut in each that they may work together.

102. The hands of a clock which gains uniformly at the rate of 15″ a day were set at sunset on the evening of the first of the month at 6 o'clock. The true time of sunrise on the 3rd was known to be a quarter to six, but the clock indicated a quarter past six. Find the error made in setting the clock on the 1st.

103. A train travels 30 miles an hour when it does not stop, and 25 miles an hour including stoppages ; in what distance will the train lose one hour by stoppages ?

104. Divide R123 among *A*, *B*, *C*, so that as often as *A* gets R3 *B* shall get $R2\frac{1}{2}$, and as often as *B* gets R4 *C* shall get $R3\frac{1}{2}$.

105. A merchant buys 4000 maunds of rice, $\frac{1}{5}$ of which he sells at a gain of 5 p. c., $\frac{1}{4}$ at a gain of 10 p. c., $\frac{1}{3}$ at a gain of 12 p. c., and the remainder at a gain of 16 p. c. If he had sold the whole at a gain of 11 p. c., he would have made ₨728 more. What was the cost of the rice per maund ?

106. A man sold 16 oranges to A, to B 4 more than to A, to C 5 less than to B ; had he sold 3 less to each he would have left only one-third of what he had ; find how many he had at first.

107. Simplify $\left\{\dfrac{1\frac{2}{5} \div 1\frac{4}{7}}{1\frac{3}{8} \div 1\frac{1}{8}} \div \dfrac{1\frac{6}{7} \div 1\frac{7}{8}}{1\frac{5}{9} \div 1\frac{9}{10}}\right\} \div \left\{\dfrac{\frac{1}{7} \div \frac{1}{8}}{\frac{1}{11} \div \frac{1}{13}} \div \dfrac{\frac{1}{17} \div \frac{1}{15}}{\frac{1}{19} \div \frac{1}{20}}\right\}$.

108. A room is 18 ft. long ; and the cost of carpeting it is ₨72. If the breadth of the room were 4 ft. less, the cost would be ₨54 ; find the breadth of the room.

109. A can mow $2\frac{1}{2}$ acres of grass in $6\frac{2}{3}$ hours, and B $2\frac{1}{8}$ acres in $5\frac{1}{3}$ hours ; in what time will they together mow a field of 10 acres, and how many acres will each mow ?

110. The cost of 12 md of wheat and 10 md of gram is ₨50 when gram is at ₨2 per md. What is the price per md. of gram when 8 md. of rice and 6 md. of gram cost ₨34, the price of rice being $\frac{1}{4}$ higher than that of wheat ?

111. Divide ₨20. 4a among 5 persons so that the share of each (except the first) may be double of the shares of all who come before.

112. A merchant bought a 50-gallon cask of wine for ₨741. Supposing it to have lost 4 gallons, at what price per dozen bottles (nine bottles holding a gallon) should he sell it in order to gain 15 p. c. upon the whole original cost ?

113. A man lost as much by selling 20 chests of tea at ₨620 per chest as he gained by selling 25 chests at ₨692 per chest ; what did each chest cost him ?

114. A man left his property to two sons and a daughter ; to the elder son he left $\frac{1}{4}$ of his property, to the younger son $\frac{1}{5}$, and to the daughter the rest, which was ₨4000 less than what the two sons together received : what was the entire property ?

115. Three lines of paling run side by side for a distance of 864 yards. The rails are respectively 4, 6 and 9 feet apart. How often will a person walking outside the palings, on looking across them, see three rails in a line ?

116. Three persons, A, B, and C, who can walk respectively 2, 3, and 4 miles per hour, start from the same place P at intervals of an hour. A starts first, and as soon as B has caught him up, B returns to the station P ; find where he will meet C.

117. A fraudulent tradesman, uses a yard measure one inch too short; what does he gain by his dishonesty in selling 20 yd. of cloth at R1. 2*a* per yard?

118. *A*, *B*, *C* had each a cup of tea, containing 4 oz., 5 oz. and 6 oz. respectively. They blended their teas and then refilled their cups from the mixture; how much of the teas of *A* and *B* are contained in *C*'s cup?

119. If by selling wine at R6 per gallon I lose 25 per cent., at what price must I sell it to gain 25 p. c.?

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120. A man, having lived at the rate of £300 a year for 6 years, finds himself in debt, and reduces his expenditure to £250 a year; he is out of debt in 4 years: what is his income?

121. Express the sum of $\dot{.}5714\dot{2}\dot{8}$ of a viss, $\frac{3}{8}$ of $\frac{1}{3\frac{3}{8}}$ of $\frac{217}{384}$ of a maund and $\frac{3301}{10138}$ of a cwt. as a decimal of one ton. [One viss = 3 lb. 2 oz.; one maund = $82\frac{2}{7}$ lb.]

122. A rectangular cistern, 12 ft. long, 10 ft. wide and 4 ft. 3 in. deep, is filled with liquid which weighs 2040 lb. How much deep must another cistern be, which will hold 196 lb. of the same liquid, its length being 7 ft. and width 3 ft. 6 in.?

123. *A* can run 100 yd. in 12 sec., and *B* in 13 sec. How much start in distance must *A* give *B* in order that they may run a dead heat?

124. The Fort-Barracks are lighted with gas from 100 burners. Find the cost of lighting them per night of 10 hours, at the rate of R$5\frac{1}{2}$ for 1000 cu. ft. of gas, assuming that for the first 3 hours each burner consumes 1 cu. in. per second, and during the remainder of the night the light is so reduced that the consumption of gas by each burner is only $\frac{3}{4}$ of that quantity per second.

125. 120 coins consist of crowns, half-crowns and florins: the values of the crowns, half-crowns and florins are as 25 : 10 : 6; how many half-crowns are there?

126. A merchant sells 60 md. of rice at a profit of 8 p. c. and 91 md. at a profit of 10 p. c.; if he had sold the whole at a profit of 9 p. c. he would have received 17 annas less than he actually did: how much per md. did he pay for the rice?

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127. A man, having a certain number of mangoes to dispose of, sells half of what he has and one more to *A*, half of the remainder and one more to *B*, half of the remainder and one more to *C*, half of the remainder and one more to *D*; by which time he has only one left; find how many he had at first.

128. Simplify $\frac{3}{5}+\frac{5}{6}-\frac{2}{3}$ of $\frac{7\frac{1}{3}-5\frac{1}{4}}{1\cdot625}+\cdot064\dot{7}4358\dot{9}$.

129. A dollar being worth *4s. 2d.* and a rouble *3s. 1½d.*, find the sum of money which can be paid by an exact number of either dollars or roubles, the number of roubles exceeding the number of dollars by 20.

130. *A* can do a piece of work in 15 days, *B* in 12 days and *C* in 10 days. All begin together; *A* leaves after 3 days, and *B* leaves 2 days before the work is done. How long did the work last?

131. A tank is 300 yd. long and 150 yd. broad; with what velocity per second must water flow into it through an aperture 2 ft. broad and 1½ ft. deep, that the level may be raised 1 ft. in 9 hours?

132. The height of the top of a flag-staff standing on a tower is 110 ft., and the height of the tower is 6 ft. more than 12 times the length of the flag-staff, what is the length of the flag-staff?

133. A merchant buys some cloth at such a price that by selling it at ₨4. *6a.* per yd. he will gain 5 p. c. on his outlay. What percentage will he gain or lose if the cloth be sold at ₨3. *14a.* per yd.?

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134. I wish to buy an equal number of 3 kinds of toys, worth respectively *1s.*, *1s. 6d.* and *2s. 6d.* each; how many can I get for £10?

135. In a book on Arithmetic an example was printed thus:

"Add together $\frac{1}{6\frac{2}{3}}$, $\frac{1}{5\frac{5}{6}}$, $\frac{1}{-}$, $\frac{1}{8\frac{1}{4}}$,"

the denominator of one fraction being accidentally omitted. The answer given at the end of the book was $\frac{511}{840}$; required the missing denominator.

136. Find the side of a square courtyard, the expense of paving which at *3s. 9d.* per sq. yd. was £42. *3s. 9d.*

137. *A* and *B* start at the same time from Calcutta to Hugli and from Hugli to Calcutta respectively, each walking at the rate of 4 miles an hour. After meeting *B*, *A* increases his rate to 4½ miles an hour, and arrives at Hugli in 1½ hours from that time. After meeting *A*, *B* reduces his rate to 3½ miles an hour. In what time will he reach Calcutta?

138. If the rent of a farm of 24 acres be £39, what will be the rent of another farm of 36 acres, 5 acres of the former being worth 6 acres of the latter?

139. A purse contains £8 . 7 . 11, made up of pennies, shillings, half-crowns and crowns, the numbers of which are proportional

to 7, 3, 2 and 5 respectively; how many of each coin are there in the purse?

140. Calculate the profit per cent. made by a book-seller, assuming that he pays 11*s*. 4*d*. for a 16-shilling book and receives 25 copies for 24.

141. A person mixes together 10 lb. of tea at Rs. 1. 4*a*. a lb., 12 lb. at Rs. 1. 6*a*., and 14 lb. at Rs. 1. 8*a*. He reserves 6 lb of the mixture for himself and sells the remainder at Rs. 1. 13*a*. 4*p*. a lb. How much does he gain in money?

142 Multiply ·047321 by 12172·8144, using only 3 lines of multiplication.

143. Three men, the length of whose strides are 2 ft. 6 in., 3 ft. and 3 ft. 6 in., walk a mile. How often do they step together?

144. *A* and *B* start on a bicycle race. *A* has 10 minutes' start, during which he goes $2\frac{1}{2}$ miles; *B* rides at the rate of 16 miles an hour. Which will win in a race of 40 miles?

145. If 3 soldiers or 10 coolies can dig 150 cu. ft. of earth in 5 days, how many coolies must be employed to assist 7 soldiers in removing 580 cu. ft. of earth so as to get it done in 4 days?

146. 12*s*. $3\frac{1}{4}d$. is divided among men, women and children, whose numbers are proportional to 3, 5 and 7 respectively; if a man receives $5\frac{1}{2}d$., a woman $3\frac{1}{4}d$. and a child $2\frac{1}{4}d$., find the number of men.

147. An article was sold so as to gain 5 p. c. on its cost price. If it had been bought at 5 p. c. less, and sold for 1*s*. less, 10 p. c. would have been gained. Find the cost price.

148. A wine merchant bought 7 gallons of wine at 17*s*. a gallon and 5 gallons at 15*s*. a gallon; he mixed the whole and added some water. The whole mixture he put into quart bottles which cost him 8*s*. 6*d*. and sold each bottle at 4*s*. and gained £1. 17*s*. 6*d*. on the whole. How much water did he mix?

149. Find the value of $\frac{15\frac{3}{4}}{7\frac{1}{2}}$ of £1 + $\frac{1}{8}$ of £140. 10*s*. 6*d*. + $\frac{3}{8}$ of 21*s*.

150. The weight of water contained in a rectangular cistern, 8 ft. long, 7 ft. wide, is $93\frac{3}{4}$ cwt. Find the depth of water in the cistern, supposing a cu. ft. of water to weigh 1000 oz.

151. 25 men are employed to do a piece of work, who could finish it in 20 days; but the men drop off by 5 at the end of every 10 days: in what time will the work be finished?

152. If 48 men, working 8 hours a day for one week, can dig a trench 235 ft. long, 40 wide and 28 deep; in what time can

12 men, working 10 hours a day, form a railway cutting of 131,600 cu. yards ? [A week = 6 working days.]

153. The sum of areas of two circles, of which the diameters are as 3 is to 4, is equal to the area of another circle 10 ft. in diameter ; find the diameters of the two circles, having given that areas of circles are to one another as the squares of their diameters.

154. A merchant sells sugar to a tradesman at a profit of 50 per cent. ; but the tradesman becoming bankrupt pays only 5 annas in the rupee. How much per cent. does the merchant gain or lose by the sale ?

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155. How many parcels of 6 lb. and 8 lb. each can a grocer make out of a hogshead of sugar, weighing 4 cwt. 3 qr. 14 lb., so as to have the same number of parcels of each sort ?

156. *A* had 10*s.* in his purse, and *B* having paid *A* $2 \times \frac{3\frac{1}{4}}{1\frac{3}{5}}$ of £1. 11*s.* 6*d.* finds that he has remaining $\frac{1}{13}$ of the sum which *A* now has ; what had *B* at first ?

157. A number is exactly divisible by 11 ; but when divided by 5, 6 or 8 leaves always the remainder 1 : find the least number which satisfies these conditions.

158. A boat's crew row over a course of $2\frac{1}{2}$ miles against a stream, which flows at the rate of 3 miles an hour, in 30 minutes. The usual rate of the stream is one mile an hour. Find the time which the boat would take in the usual state of the river.

159. If the cost of 11 miles of iron rails be R55000 when iron is selling at R95 a ton, what will be the cost of 19 miles of the same rails when iron is selling at R105 a ton ?

160. A circular plate of gold, 10 in. in diameter and 2 in. thick, is melted and formed into two other circular plates, each 1 in. thick, whose diameters are as 3 to 4 ; find the diameters.

161. A man buys goods for R750, and sells $\frac{1}{3}$ of them at a loss of 4 p. c. ; by what increase per cent. must he raise that selling price in order that by selling the rest at the increased rate he may gain 4 p. c. on the whole transaction ?

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162. A person gives 53 guineas for 184 gallons of wine ; how much water must he add to it, if he wishes to sell it at 5*s.* 3*d.* a gallon and make a profit of 7 half-guineas ?

163. A vessel containing 21·84375 gallons of water is emptied by a pitcher which contains when full ·078125 gallon. How many times can the pitcher be filled entirely, and what fraction of a pint will it contain when the last quantity of water is poured into it ?

164. A room is 8 yd long; the cost of carpeting it is Rs 94. 8*a*., and that of papering is Rs 86 10*a*. If the breadth of the room were 1 yd. more and its height 1 ft. less, the cost of carpeting would be Rs 110 4*a*. while the cost of papering would remain the same. Find the breadth and height of the room.

165. *A* and *B* run a race; *A* has a start of 40 yd, and sets off 5 min. before *B*, at the rate of 10 miles an hour. How soon will *B* overtake him if his rate of running is 12 miles per hour?

166. If the gas for 5 burners, lighted 5 hours every evening for 10 days, cost Rs 3. 12*a*., what will be the cost of 75 burners which are lighted 4 hours every evening for 15 days?

167. Find the three highest integral numbers whose sum is under a thousand, so that the first may be $\frac{2}{5}$ of the second and second $\frac{4}{5}$ of the third.

168. A tradesman sells one kind of sugar at 3*a*. per seer and loses 20 p. c., and another kind at 5*a*. per seer and gains 25 p. c. He mixes the two together in equal proportions and sells the mixture at 6*a*. per seer. What is now his gain per cent.?

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169. Two equal sums are divided, the one among 36 men, and the other among a certain number of women; each man receives Rs 1. 4*a*. and each woman 10 annas less; how many women were there?

170. Simplify $\dfrac{\frac{4}{9}\text{ of }1\frac{1}{2}-\frac{3}{4}\text{ of }\frac{5}{6}}{\frac{9}{100}(3\frac{1}{3}-\frac{1}{16}+5\frac{1}{6})} \div \dfrac{6\frac{7}{8}}{4+\dfrac{1}{\frac{5}{6}\text{ of }2\frac{4}{15}}}$.

171. Three equal circular wheels revolve round a common horizontal axis; the first makes a revolution in $5\frac{1}{3}$ minutes, the second in $2\frac{2}{3}$ minutes, and the third in $3\frac{3}{7}$ minutes. Three marks, one in each wheel, are in a horizontal line at a certain moment. What is the shortest interval after which they will be in a horizontal line again?

172. *A* can do a piece of work in 6 hours, *B* in 8 hours and *C* in 10 hours; how long will it take *C* to complete a piece of work, $\frac{1}{2}$ of which has been done by *A* working 7 hours and *B* working 8 hours?

173. *A* walks $2\frac{1}{2}$ miles in 40 min., taking exactly a yard each step; in what time will *B* walk $4\frac{3}{8}$ miles when his stride is 40 in. and he takes 21 steps while *A* takes 22?

174. Three persons, *A*, *B*, *C*, agree to pay their hotel bills in the proportion 4 : 5 : 6. *A* pays the first day's bill which amounts to £1. 5*s*. 5*d*.; *B* the second which amounts to £1. 16*s* 1*d*.; and *C* the third which amounts to £1. 18*s*. 6*d*.; how must they settle their accounts?

175. A person bought a French watch bearing a duty of

25 per cent., and sold it at a loss of 5 per cent.; had he sold it for £3 more, he would have cleared 1 per cent. on his bargain. What had the French maker for the watch?

176. An equal number of men, women and boys earn ₨165 in 6 days. If a woman earns 13*a.* 4*p.* a day, a man 8*a.* more, and a boy 8*a.* less, how many are there of each?

177. What sum increased by $\frac{2}{3}$ of $\frac{7}{8}$ of $\frac{3}{40}$ of itself, amounts to £2463?

178. The length, width and depth of a cistern are 8 ft., 5 ft. 4 in. and 4 ft. 6 in. respectively. How many gallons does it contain, having given that a cu. ft. of water weighs 1000 oz. and that a pint of water weighs a pound and a quarter?

179. *A* and *B* are termini of a railway 144 miles long. A fast train starts from *B* at 9 A. M.; another fast train, travelling at the same rate, starts from *A* at 10 A. M. A slow train starts from *B* at 10-20 A.M.; the fast train from *A* meets the other fast train at 11-30 A. M., and the slow train at 12-32 P. M. Find the rates at which the trains travelled.

180. If ₨1 = 1*s.* 10½*d.*, £1 = 4·84 dollars, and 1 dollar = 5·2 francs, find the value in francs of 10 lacs of rupees.

181. Three merchants, *A*, *B*, *C*, trading with a capital of £3850, find after a certain time that their respective shares are increased by £66 . 7 . 6, £59 . 8 . 7 and £66 . 13 . 11; how much did *A* subscribe to the original capital?

182. A grocer buys 200 lb. of tea, and sells 180 lb. for the same amount that he gave for the whole. The rest he sells at a profit of 20 per cent. What is his gain per cent. on the whole outlay?

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183. The large wheel of an engine is 20 ft., and the small wheel 12 ft., in circumference. If the large wheel slips on an average 2 inches in every revolution, how many revolutions will the small wheel make more than the large one in going a distance of 12 mi. 1728 yd.?

184. Calculate correctly to 7 places of decimals the value of

$$\frac{1}{9}+\frac{1}{3\cdot9^3}+\frac{5}{5\cdot9^5}+\frac{1}{7\cdot9^7}+\ldots\ldots$$

185. The circumferences of the wheels of a carriage are $6\frac{3}{14}$ ft. and $8\frac{1}{18}$ ft.; what is the least distance in which both the wheels will simultaneously complete an integral number of revolutions? How often will the lowest points of the two wheels at starting touch the ground together in 10 miles?

186. In a 200-yd. race *A* beats *B* by 20 yd., and *C* by 40 yd. By how many yards can *B* beat *C* in a 100-yd. race?

187. On a piece of work 2 men and 5 boys are employed, who do $\frac{1}{2}$ of it in 6 days; after this 1 man and 1 boy more are put on, and $\frac{1}{3}$ more is done in 3 days: how many more men must now be put on if the work is to be completed in 1 day more?

188. *A*, *B*, *C* invest capital to the amount of £800, £600 and £500; *A* was to have $\frac{2}{3}$ of the profits which amount to £330; find *C*'s share of the profits.

189. A tradesman defrauds his customers (i) by an adulteration of the article to the extent of 7 per cent., (ii) by using a balance which indicates 1 lb. when the amount in the other scale is really 15 oz. Which of the two practices is the more fraudulent, and to what extent is the customer cheated when he orders 1 lb. of the commodity?

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190. Find the distance between two towns when R309. 5*a*. 4*p*. is paid for the fare of 17 first class passengers at 1*a*. 8*p*. a mile, of 26 second class at 1*a*. 2*p*. a mile, and of 40 third class at 8*p*. a mile.

191. Find the value of $\left\{\dfrac{3\frac{1}{2} \text{ of } 5\frac{5}{8}}{2\frac{5}{8} \text{ of } 3\frac{1}{3}} \div \dfrac{2\frac{2}{7} \text{ of } 1\frac{1}{2}}{3\frac{1}{6} \text{ of } 7\frac{5}{7}}\right\}$ of $\dfrac{1s.\ 5d.}{4s.\ 7d.}$ of $\dfrac{2 \text{ ft. } 3 \text{ in.}}{5 \text{ ft. } 5 \text{ in.}}$ of 24 weeks 4 days 19 hours.

192. How many poles of fencing are required to enclose a square park containing 27 ac. 12 po. 1 yd.?

193. *A*, *B*, *C*, can do a piece of work in 6, 8, 10 days respectively. They begin to work together; *A* continues to work till it is finished, *B* leaving off 2 days, and *C* 1 day before the work is completed. In what time is the work finished?

194. If the supply of a number of persons with bread at $7\frac{1}{2}d$. the loaf for 31 days cost £27. 18*s*.; what will it cost to supply $\frac{3}{5}$ of that number for 20 days at $6\frac{1}{4}d$. the loaf?

195. *A*, *B*, *C* purchase a farm for R10000, of which *A* pays R4000; they sell it so as to gain a certain sum, of which *B* takes R275 and *C* R175; find *A*'s share of the profit.

196. One company guarantees to pay 5 per cent. on shares of 1000 rupees each; another guarantees to pay $4\frac{5}{8}$ per cent. on shares of 75 rupees each; the price of the former is 1245 rupees and of the latter 85 rupees. Compare the rates of interest which the shares return to the purchasers.

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197. If 5000 people took in hand to count a billion of sovereigns, and beginning their work at the commencement of the year 1852, could each count on the average 100 sovereigns in a minute (without intermission), when would they finish their task?

198. The total area of three estates is 1768 acres. If the areas of the two smaller estates be respectively three-fifths and two-thirds of that of the largest, find the acreage of each.

199. There are 3 pendulums, the first makes 35 beats in 36 seconds, the second 36 beats in 37 seconds, and the third 37 beats in 38 seconds. Supposing they commence together, find how many times they will again beat coincidently in 24 hours.

200. Sound travels at the rate of 1142 ft. per second; what is the distance of the thunder cloud, when the thunder succeeds the lightning at an interval of 9 seconds?

201. If 4 men and 6 women can do a piece of work in 5 days, which 5 men and 10 children can do in 4 days, or 3 women and 4 children can do in 10 days; find (i) how many men, (ii) how many women, (iii) how many children, could do the work in one day.

202. *A* and *B* enter into partnership; *A* puts into the business R5000 more than *B*, who, as acting partner, is to have a salary of R125 a month; at the end of 2 years the gross profits computed at $\frac{1}{6}$ of the capital per annum, are found to be R7000, from which *B*'s salary is to be paid: find each one's share of the net profit.

203. The 3 per cents. are at $85\frac{1}{8}$; what price should the $3\frac{1}{2}$ per cents. bear, that an investment may be made with equal advantage in either stock? And what interest would be derived by so investing 5000*l*.

204. Find the least sum of money that must be subtracted from £660. 7*s*. 4*d*. to make the remainder exactly divisible by 39.

205. What decimal must be added to

$$\frac{\frac{5}{6}(\cdot\dot{3}-\cdot 2)+\frac{1}{4}(\cdot\dot{3}+\cdot 2)}{\frac{1}{7}(2\cdot\dot{3}+\frac{2}{11})+\frac{1}{11}(\frac{11}{3}-\frac{4}{7})} \text{ to produce unity ?}$$

206. If gold can be beaten out so thin that one tola will form a leaf of 20 sq. yards, how many of these leaves will make up the thickness of a sheet of paper, the weight of a cu. inch of gold being $52\frac{11}{12}$ tolas and 432 sheets of the paper in thickness going to an inch?

207. A race-course is $\frac{1}{2}$ a mile long: *A* and *B* run a race and *A* wins by 10 yards; *C* and *D* run over the same course and *C* wins by 30 yards; *B* and *D* run over it and *B* wins by 20 yards; if *A* and *C* ran over it, which would win, and by how much?

208. Four men are employed to reap a field, and after working 5 days they have cut 10 acres; 2 more men are then put on, and the whole is finished in 3 more days. How many acres are there in the field;

209. *A*, *B* and *C* are employed to do a piece of work for R529;

A and *B* together are supposed to do $\frac{10}{23}$ of the work, and *B* and *C* together $\frac{8}{23}$ of the work : what should *A* be paid ?

210. If R16430 be invested in the Govt. $4\frac{1}{2}$ per cent. loan at 106, what is the monthly income derived ? Supposing that the loan is paid off at par in 10 years, what would be the rate of simple interest on the sum invested ?

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211. 120 tons of coal are purchased for £87. 16. 9 ; find, to the nearest farthing, the price at which they must be retailed per ton, so that no loss may be incurred ; and at that price what profit will accrue ?

212. Reduce to a decimal correct to 6 places :

$$\frac{1}{1\cdot 3}+\frac{1}{3\cdot 3^3}+\frac{1}{5\cdot 3^5}+\frac{1}{7\cdot 3^7}+\ldots\ldots\ldots$$

213. Find the greatest unit of time by means of which 11 hr. 31 min. 18 sec. and 23 hr. 4 min. $27\frac{1}{2}$ sec. can both be expressed as integers.

214. A man does $\frac{3}{8}$ of a piece of work in 18 days, and then gets a boy to help him. They work together for 3 days, when the boy leaves, and the man finishes the work in $7\frac{1}{2}$ days more. How long would it take the boy to do the whole ?

215. If 10 horses and 98 sheep can be kept 9 days for £37. 17. 6 ; what sum will keep 45 horses and 216 sheep for 40 days, supposing 5 horses to eat as much as 76 sheep ?

216. *A* starts business with R1200, and subsequently admits *B* who brings R1600. At the end of the year *A* receives $\frac{3}{5}$ of the profits ; when was *B* admitted ?

217. A man who has a certain capital calculates that if he invest it in $3\frac{1}{2}$ per cent. stock at 91, his income will be £25 more than if he invest it in 3 per cent. stock at 88. What is his capital ?

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218. A tradesman buys 200 lb. of tea for £16, intending to gain one-fourth of his outlay by sale ; but two pounds' worth at this calculation being damaged, at what price shall he sell the remainder per lb. to gain as much upon the whole outlay as he intended ?

219. Express $(\frac{9}{10}+2\frac{1}{2})-(2\frac{3}{8}-1\frac{3}{4})\times\{(5\frac{1}{4}\times 7\frac{2}{3})\div 16\frac{1}{16}\}$ in its simplest form.

220. •The diagonal of a square court-yard is 100 ft. ; find the area.

221. Sound travels at the rate of 1140 feet a second. If a shot be fired from a ship moving at the rate of 10 miles an hour, how far will the ship have moved before the report is heard $14\frac{1}{4}$ miles off ?

222. The length of the minute-hand of a church clock is $5\frac{1}{4}$ feet; what distance will the end of it travel through in 35 days, if 7 times the circumference of a circle be 22 times its diameter?

223. Three men *A*, *B*, *C*, undertake to complete in 20 days a piece of work for R247. 8*a*. *A* furnishes 10 men for 8 days and 6 men for the remaining days; *B* furnishes 7 men for 7 days and 12 men for 12 days; *C* furnishes 15 men who work on alternate days only until the work is completed. Find *A*'s share of the sum.

224. A person having R8,500 in 4 per cent. Govt. bonds sells out when they are at $8\frac{1}{4}$ per cent. discount, and with the amount thus realised purchases 5 per cent. bonds which are at $6\frac{3}{8}$ per cent. premium: what does he gain or lose in annual income by the change?

225. A contractor employs 100 men, 40 of whom work 10 hours on week days and only 5 hours on Sunday; the rest work 8 hours a day. If the wages of the former be 5*p* per hour and of the latter 4*p*. per hour, what is the amount of wages paid in 4 weeks?

226. Two chests of tea of the same size and quality are consigned to *A*, *B*, *C*. *A* at first was to have $\frac{4}{5}$ of a chest, *B* $\frac{5}{8}$, and *C* the rest. But *A*, *B* purchase $\frac{8}{11}$, $\frac{2}{11}$ of *C*'s share respectively. How much will each have?

227. Find the side of the largest square tile, with which a court, 33 yd. 1 ft. 7 in. long and 20 yd. 11 in. broad, can be paved.

228. In a bicycle race of 2 miles over a circular course of 1 furlong, the winner in his last round overtook the second at a point in his 15th round. Their paces were as 159 to 149 At what distance was this point from the winning post?

229. If 3 men can do as much as 7 boys in a day, how many days will it take 25 boys to finish a piece of work of which 12 men have done a quarter in 13 days?

230. *A*, *B*, *C* hold a pasture in common for which they pay R16 per month; they put on it 70, 50 and 40 sheep respectively. *A* sells $\frac{3}{7}$ of his flock to *B* after 4 months, and after 3 months more *C* sells $\frac{3}{8}$ of his to *A*. How much of the rent should each pay at the end of the year?

231. A person bought 10 Bank of Madras shares at R1510 each and for 5 years got interest on his investment at the rate of $5\frac{1}{3}$ per cent. He then sold his shares at a loss of $22\frac{1}{2}$ per cent. How much did he make by the transaction, and what rate per cent. per annum had he for his money?

232. A certain number of cows and twice as many sheep were bought for R94. 6*a*.; the cows cost R10 3*a* 6*p*. each and the sheep R4. 5*a*. 3*p*. each: how many sheep were bought?

258. Gold is 19 times as heavy as water, and copper 9 times. In what ratio should these metals be mixed that the mixture may be 15 times as heavy as water?

259. When the 3 per cents. were at 90 I found that by selling out and investing in the 4 per cents at 95 I could improve my income by R243. What was the amount of my stock in the 3 per cents.?

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260. A person has in his drawer 15 piles of rupees, each containing 20: his servant steals them and puts in their place 15 piles, each consisting of 19 double pice with a rupee at the top. How much does the person lose?

261. A person owes the sum of R31500, and R8500; and his property amounts to R14125 only. How much is he able to pay in the rupee; and what is the loss upon the second debt?

262. A rectangular piece of ground of 243 sq. yd. is one-third as broad as it is long; what is the distance round it?

263. A passenger train going 41 miles an hour, and 431 ft. long, overtakes a goods train on a parallel line of rails. The goods train is going 28 miles an hour, and is 713 ft. long. How long does the passenger train take in passing the other?

264. The distance by rail from Turin to Venice is 420 kilometres, and the first-class fare is 56 lire; find the same rate in Indian money, the fare from Calcutta to Benares, a distance of 480 miles, reckoning 7 lire equal to R3 and 8 kilometres to 5 miles.

265. 40 lb. of coffee, at 2*s.* 6*d.* a lb., were mixed with a certain quantity of chicory at 1*s.* 9*d.* a lb., and the resulting mixture was worth 2*s.* a lb. How many pounds of chicory were there in the mixture?

266. How much money must be invested in the 3 per cent. consols when they are at 92⅜, to produce the same income as would be produced by R1520 invested in the 3½ per cents. at 95?

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267. If R10 . 7 . 6 be gained by selling an article for R79 . 10 . 9, how much would have been gained or lost by selling it for R59 . 7 . 6?

268. Find, by Practice, to the nearest penny, the rent of 375·3675 acres at £2. 19*s.* 10½*d.* per acre.

269. Determine, by Duodecimals, the area of a rectangle whose adjacent sides are respectively 9 ft. 3½ in. and 6 ft. 4½ in.

270. *A* can beat *B* by 5 yd. in a 100-yd race, and *B* can beat *C* by 10 yd. in a 200-yd. race; by how much can *A* beat *C* in a 400 yd. race?

271. If 210 coolies, in 7 days of 10 hours each, dig a channel,

1 mile long, 6 feet broad and 2 feet deep; in how many days of 7 hours each should 35 coolies dig a channel, 660 feet long, $7\frac{1}{8}$ feet broad and $2\frac{1}{4}$ feet deep? And how many cubic feet does each cooly dig in an hour?

272. The average of eleven results is 30; that of the first five is 25, and that of the last five is 28. Determine the sixth result.

273. What amount must be invested in the $4\frac{1}{2}$ per cent. stock at $103\frac{3}{4}$, in order to obtain, after deducting an income-tax of $3\frac{1}{8}$ per cent., a clear income of R4000 a year?

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274. 4 thalers, 6 half-crowns and 8 florins amount to £2; what is the value of a thaler?

275. A reduction in the income-tax diminishes a tax, which is R15 when the tax is 8 pies in the rupee, by R3 . 12 . 0: what is the diminished rate of the tax?

276. The length of a room is twice its breadth and 4 times its height, and it contains 216 cu. yards of air; find its length.

277. *A* can reap a field in 5 days, and *B* in 6 days, each working 11 hours a day; in what time could they together reap it, working 10 hours a day?

278. If 38 men working 6 hours a day can do a piece of work in 12 days, find in what time 57 men working 8 hours a day can do a piece of work twice as great, supposing 2 men of the first set to do as much work in 1 hour as 3 men of the second set can do in $1\frac{1}{2}$ hours.

279. The average weight of 5 men is 5 st. 7 lb.; the average weight is diminished by 7 lb. when the weight of a boy is included: what is the weight of the boy?

280. A share-holder in a commercial company receives one year a dividend of 5 per cent. on his shares The next year he receives a dividend of $7\frac{1}{2}$ per cent. and finds that he is R412. 8*a*. richer. Find the amount of his shares.

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281. To march at quick step is to take 108 paces of 2 ft. 8 in. per minute; what rate is this per hour?

282. A society subscribed R21. 5*a*. 4*p*. to a charity, each member paying as many pies as there were members in the society; find the number of members.

283. Find, by Duodecimals, the volume of a block of marble, 3 ft. 7 in. long, 2 ft. $3\frac{1}{2}$ in wide and 1 ft. $2\frac{1}{2}$ in. deep.

284. A train, 880 feet long, overtook a man walking along the line at the rate of 4 miles an hour, and passed him in 30 seconds; the train reached the next station in 15 minutes after it had passed the man. In what time did the man reach the station?

285. If 40 men and 50 boys can do a piece of work in 6 days, working 6 hours a day, in how many days will 8 men and 20 boys do a piece of work half as large again, working 7 hours a day, assuming that a man does as much work in 3 hours as a boy in 5 hours?

286. The average age of 8 men is increased by 2 years, when one of them, whose age is 24 years, is replaced by a fresh man; what is the age of the new man?

287. If the price of the 4 per cents. just before the payment of a half-yearly dividend be 93, what ought to have been the price 3 months previously, supposing no change in the value of money to have taken place during that interval?

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288. The weekly wages at a mill amount to £186. 4*s*. In the mill a certain number of women are emloyed at 2*s*. 10*d*. a day, five times as many men at 5*s*. 6*d*. a day, and 6 times as many boys at 2*s*. 4*d*. a day; how many men are employed?

289. If the income-tax be 7*d*. in the £ in the first half of the year, and $3\frac{1}{2}$*d*. in the second, what is the net income of a gentleman whose gross annual receipts are £1542 . 10 . 6?

290. An open cistern, made of sheet iron a quarter of an inch thick, is internally $62\frac{1}{2}$ in. long, 36 in. wide and 24 in deep; find the weight of the cistern when full of water, if iron weighs 7 times as much as water and a cu. ft. of water weighs 1000 oz.

291. In a two-mile race *A* wins, *B* being 22 yd. behind, and *C* 106 yd. behind *B*. By how much would *B* beat *C* in a three-mile race in which *A* does not run?

292. If the wages of 18 coolies for a month amount to R85 when rice is 24 seers per rupee, what ought the daily pay of a cooly be in proportion when the price of rice is R2. 10*a*. 8*p*. per maund?

293. *A* and *B* started on a race and ran a distance exactly together. Then *B* began to fail and gave up the race when he had run 56 yards farther, *A* having gone during the same time 320 yards. The average of the entire distances run by the two men was 1188 yards. What distance had they run together?

294. The £23 shares of one company pay a dividend of £1 per share; the £15 shares of another yield £·725 per share. The market value of the former is £24·92, of the latter £17. Compare the rates of interest returned to the purchasers.

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295. A man bought 100 oranges at 2 a pice, and 100 more at 3 a pice, and mixed and sold the whole at 5 for 2 pice; how much did he lose?

296. Find, by Practice, the cost of fencing 3 mi. 3 fur. 180 yd. 1 ft. 6 in. of road at £479. 15*s*. per mile.

297. An open cistern, made of sheet iron $\frac{1}{2}$ inch thick, is externally 10 in. long, 8 in. broad and $5\frac{1}{2}$ in. deep; find the price of the cistern at R8 per cwt., if a cu. ft. of iron weighs $4\frac{1}{2}$ cwt.

298. *A* does half as much work again as *B* in the same time, and *B* does one-third as much again as *C*; working together they can do a certain work in 5 days; but if after working 2 days *A* leaves off, how long will *B* and *C* take to finish it?

299. When rice is 10 seers the rupee, 7 persons can be fed for 30 days at a certain cost. For how many days can 6 persons be fed at the same cost when rice is 14 seers the rupee?

300. If the daily wages of a labourer rise from 4*a*. 9*p*. to 6*a*., what percentage of the increase in the price of food and other commodities will cause his position to be unaltered?

301. A person buys 5 shares in a company, and sells three of them at a gain of 10 per cent. and the remaining two at a gain of $16\frac{2}{3}$ per cent. The gain on the latter sale is £2 . 19 . $7\frac{1}{2}$ more than on the former. How much did he pay for each share?

302. A man buys 25 seers of milk at 1*a*. 6*p*. a seer, and sells it at 1*a*. 3*p*. a seer, making a profit of 5 annas; how many seers of water did he add to the milk?

303. Now that the income-tax is 5 pies in the rupee, a person's net income is R374 per mensem; what will it be when the income-tax is raised to 7 pies?

304. Find, by Duodecimals, the area of a square whose side is 12 ft. 8 in. 4 pt.

305. A train starts from *A* at 12 o'clock and runs towards *C*, which is 100 miles distant, at the rate of 30 miles an hour; at the same time the mail coach starts for *C*, from *B*, which is half way between *A* and *C*, and runs at 10 miles an hour; at what distance from *C* will it be overtaken by the train?

306. If 13 solid inches of copper balance 17 of iron, and 15 of iron balance 16 of tin, and 19 of tin balance 12 of zinc, how many solid inches of zinc balance 2470 solid inches of copper?

307. If the income-tax be 6 pies in the rupee for the first half of the year and 3 per cent. in the second, what is the gross income of a gentleman whose net annual receipts amount to R1454. 1*a*.?

308. What sum must a person invest in the 3 per cents. at 90, in order that by selling out £1000 stock when they have risen to $93\frac{1}{2}$, and the remainder when they have fallen to $84\frac{1}{2}$, and investing the whole proceeds in the 4 per cents. at par he may increase his annual income by £9. 5*s*.?

309. Divide Rs115. 2*a*. among 20 boys and 25 girls, so that each boy may receive 12 annas more than each girl; how much will each boy receive?

310. Three-fifths of the square of a certain number is 126·15; what is the number?

311. An open cistern whose capacity is 4320 gallons is externally 14·1137 ft. long, 10·25 ft. wide and 5·16 ft. deep; the sides are $1\frac{1}{2}$ in. thick; find the thickness of the bottom, having given that a gallon contains 277·274 cu. inches.

312. *A* and *B* walk a race of 10 miles; *A* gives *B* 20 minutes' start; *A* walks uniformly a mile in $17\frac{1}{2}$ minutes and catches *B* at the 8th mile-stone: find by how much *B* lost in time and space.

313. If 17 men can build a wall 100 yd. long, 12 ft. high and $2\frac{1}{2}$ ft. thick, in 25 days, how many men will build a wall twice the size in half the time?

314. In 1861 three towns had populations of 17650, 19600, 18760 respectively. In 1871 the population of the first had decreased 18 per cent., that of the second had increased 21 per cent., while the population of the third had increased by 4690; find the change per cent. in the total population of the three towns.

315. A gentleman invests Rs5600 in the $5\frac{1}{2}$ per cent. Govt. paper, and derives therefrom an annual income of Rs275. At what premium was the $5\frac{1}{2}$ per cent. paper at the time he invested?

316. Find the circumference of the wheel of a locomotive, which makes 5 revolutions in a second, and which performs a journey of 30 miles in 44 minutes.

317. A man has an income of £200 a year; an income-tax is established of 7*d*., in the £, while a duty of $1\frac{1}{2}d$. per lb. is taken off sugar; what must be his yearly consumption of sugar that he may just save his income-tax?

318. *A*, *B*, *C* are three spouts attached to a cistern. *A* can fill it in 20 min., *B* in 30, and *C* can empty it in 40 min. If *A*, *B* and *C* be opened successively for one minute each, in what time will the cistern be filled?

319. A besieged garrison consists of 300 men, 120 women and 40 children, and has provisions enough for 200 men for 30 days. If a woman eats $\frac{2}{3}$ as much, and a child $\frac{1}{2}$ as much, as a man, and if after 6 days 100 men with all the women and children escape, how long will the remaining provisions last the garrison?

320. The price of rice being raised 50 per cent., by how much per cent. must a house-holder reduce his consumption of that article so as not to increase his expenditure?

321. The owner of 4 per cent. Govt. paper, bringing in R8976 per annum, exchanges it for 5 per cent. paper. His annual interest is increased by R44. What is the increase or decrease of his nominal capital ?

322. A bill on London for £175 drawn at 6 months after sight, is purchased at Madras, the rate of exchange being 2*s* 0$\frac{3}{8}$*d.* the rupee. Four months before it becomes due, it is discounted in London at the rate of 2$\frac{1}{2}$ per cent. (per annum) discount. What was paid for the bill in Madras, and what does it realise in London ?

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323. A man laid out £30. 15*s.* in spirits which he bought at 15*s.* a gallon ; he ratailed them at 17*s.* 6*d.* a gallon, making a profit of £4. 5*s.* : how many gallons must he have lost by leakage ?

324. Arrange $\sqrt{2}$, $\sqrt[3]{3}$ and $\frac{4}{3}$ in order of magnitude.

325. Two trains, running at the rates of 25 and 20 miles an hour respectively on parallel rails in opposite directions, are observed to pass each other in 8 seconds, and when they are running in the same direction at the same rates as before, a person sitting in the faster train observes that he passes the other in 31$\frac{1}{2}$ seconds ; find the lengths of the trains.

326. If 6 dollars and 6 roubles are together worth £1. 13*s.* 9*d.*, and 4 dollars and 8 roubles are together worth £1. 11*s.* 8*d*, what is the value of 6 dollars and 8 roubles ?

327. In an examination *A* obtains 10 per cent. less than the minimum number of marks required for passing : *B* obtains 11$\frac{1}{9}$ per cent. less than *A* ; and *C* 41$\frac{3}{17}$ per cent. less than the number of marks obtained by *A* and *B* together. Does *C* pass or fail ?

328. I have R6500 to invest in public securities Will it be most to my advantage to invest it in the 5 p. c. Govt. loan which is at 10$\frac{3}{4}$ per cent. discount. or to purchase at par Treasury Bills which bear an interest of 3 pies per cent. per diem ? Calculate the difference.

329. If the par of exchange be two English shillings for the Indian rupee, but if an Indian bill of exchange for R540. 12*a.* be negotiated in London for £51. 10*s.*, how much per cent. below par is the rate of exchange ?

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330 On Monday January 3, 1888, a man commenced to subscribe for a daily pice paper (published on week days only) ; what had he spent by June 13th of the same year ?

331. A gentleman's income is diminished by £150 ; but the income-tax being raised from 6*d.* to 7*d.* in the £, he pays the same amount of tax as before ; find his present income.

332. *A* and *B* start to run a race ; their speeds are as 17 to 18.

A runs $2\frac{1}{2}$ miles in 16 min. 41 sec.; *B* finishes the course in 34 min.: determine the length of the course.

333. If 5 men and 8 boys reap 9 acres in 10 days, and 4 men and 4 boys reap 3 acres in 5 days, how many acres will 2 men and 3 boys reap in 7 days?

334. To 432 gallons of a mixture of brandy and rum, which contains $8\frac{3}{4}$ per cent. of brandy, some water is added, and the proportion of brandy in the mixture, is thereby diminished to $7\frac{1}{2}$ per cent. How much water is added?

335. A person who has £1900 Russian 4 per cent. stock sells out at 104 and devotes £952. 13*s*. 4*d*. to the purchase of 3 p. c. consols at 95, and lends the rest of the sum realised on mortgage. What interest must he ask for his money that his income may be the same as before?

336. If the rate of interest for money be 3 per cent., what should be the rate of exchange for bills payable at sight in England when the rate for those payable 4 months after sight is 1*s*. $8\frac{1}{8}$*d*. per rupee?

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337. A merchant buys 60 yards of cloth; he sells half of it at a gain of 3 annas per yard, and the remainder at a gain of 2 annas per yard, and realises R44. 1*a*. What was the cost price per yard?

338. A man buys a number of mangoes for R9, the price in pies of each mango being equal to the square root of the number purchased; find the number purchased and the price of each.

339. A train which travels at the uniform rate of 30·8 ft. a second, leaves Madras at 7 A. M.; at what distance from Madras will it meet a train which leaves Arconum for Madras at 7·20 A. M., and travels one third faster than it does, the distance from Madras to Arconum being 42 miles?

340. If 5 men, 2 women and 3 boys, or 6 men and 4 boys, can mow 3 acres in 5 days; how many acres would 3 men, 2 women and one boy mow in 11 days. supposing a man to do as much work as 3 boys?

341. A person loses in his first year 23 per cent. of his capital, but in the next year he gains 40 per cent. of what he had at the end of the first year, and his capital is now R720 more than it was at first; find his original capital.

342. A person invested equal sums of money in the 3 per cents. at $97\frac{1}{2}$, and in the $3\frac{1}{2}$ per cents. at $102\frac{1}{2}$; his resulting income was £259. 10*s*. How much did he invest?

343. A merchant in London receives two bills, drawn at 4 months after sight, each for R5000; one he discounts immediately,

the rate of interest being 3 per cent. per annum; the other he keeps till maturity, and then exchanges at the rate of 1*s*. 9*d*. per rupee, and finds that he has got as much as he did for the first bill. What was the rate of exchange when the first bill was discounted?

344. A man, having bought 128 yards of cloth for ₨80, sells one-fourth at a loss of 2 annas per yard; by how much must he raise that selling price, in order that, by selling the rest at the increased rate, he may gain 2 annas per yard on the whole?

345. Incomes below £150 a year being subject to 5*d*. in the £ income-tax, and incomes above £150 to 7*d* in the £; find what income above £150 a man must have, that he may be just 7$\frac{1}{2}$*d*. a year poorer than a man who has £149. 10*s*. a year.

346. *A* and *B* run a mile, and *A* wins by 160 yd.; *A* and *C* run over the same course and *A* wins by 20 min.; *B* and *C* run over it and *B* wins by 12 min. In what time can *A* run a mile?

347. If 16 darics make 17 guineas, 19 guineas make 24 pistoles, 31 pistoles make 38 sequins, then how many sequins are there in 1581 darics?

348. What sum must be paid on the insurance of a cargo of the value of ₨33575. 4*a*. so that in case of loss the cargo and all expenses of insurance may be recovered? The premium is at the rate of 4·725 per cent., policy duty 3$\frac{1}{8}$ annas per cent. and agent's commission $\frac{1}{2}$ per cent.

349. A person has £26041 of a 4 per cent. stock. He saves each year $\frac{1}{4}$ of his income, which he invests at 4 per cent. What is his income in the 4th year?

350. If gold be at a premium of 5 per cent, and a person buy goods marked 300 rupees, and offer gold to the amount of 300 rupees, what change ought he to receive in notes, 5 per cent. being abated for ready payment?

PROBLEMS. 175.

1. By what number less than 1000 must 4389 be multiplied so that the last three figures (to the right) of the product may be 438?

2. If 5 cwt. 3 qr. 14 lb. cost £6 per cwt., what will be the cost per pound when the cost of the whole has been reduced by £7. 16*s*. 8*d*.

3. On measuring a distance of 32 yards with a rod of a certain length it was found that the rod was contained 41 times with half an inch over; how many inches will there be over in measuring 44 yards with the same rod?

4. Find the least number above 1000, which when divided by 5 or by 6 or by 9, will leave the same remainder 3.

5. A bill of £100 was paid with guineas and half-crowns, and 48 more half-crowns than guineas were used; find how many of each were paid.

6. *A* has twice as much money as *B*. They play together and at the end of the first game *B* wins from *A* one-third of *A*'s money; what fraction of the sum which *B* now has must *A* win back in the second game that they may have exactly equal sums?

7. What is the smallest whole number which is exactly divisible by $1\frac{5}{28}$, $2\frac{2}{21}$ and $3\frac{1}{7}$?

8. *A* pays £9 . 3 . 4 more rates than *B*, their incomes being equal: living in different towns they are rated at 2*s.* and 1*s.* 4*d.* in the £ respectively; what is their income?

9. A pint of water weighs a pound and a quarter, and a cu. foot weighs 1000 oz.; how many gallons are there in a cu. foot? How many gallons will fill a cistern 5 ft. long, $2\frac{1}{2}$ feet wide and 2 ft. deep?

10. A gallon contains 277·274 cu. in.; a cu. ft. of water weighs 1000 oz. How many gallons weigh a ton? and what is the weight of a pint?

11. If 162 gallons fill a cistern $5\frac{1}{8}$ ft. by $4\frac{1}{3}$ ft. by $1\frac{1}{8}$ ft., find the number of cu. inches in a pint.

12. If a cu. inch of water weighs 252·458 grains, which is the more accurate of the following rough statements:—a cu. ft. of water weighs 1000 oz., a cu. yd. weighs $\frac{3}{4}$ of a ton?

13. If a decilitre be ·052 gallon, find the value of a pint of liquid which is worth 2 francs the decilitre: 1200 francs being equal to £49

14. Three men are employed on a work, working respectively 8, 9, 10 hours per day, and receiving the same daily wages. After three days each works one hour a day more, and the work is finished in three days more. If the total sum paid for wages be £2 . 7 . $6\frac{1}{2}$, how much of it should each receive?

15. The sum of two numbers is 5760, and their difference is equal to one-third of the greater: find the numbers.

16. Two casks contain equal quantities of beer; from the first 34 quarts are drawn, and from the second 80; the quantity remaining in one cask is twice that in the other. How much did each cask originally contain?

17. Shew that if the price in rupees of a cwt. of goods is divided by 7, the result is the price in annas of a lb. weight of the goods.

18. If R72 be divided among 5 men, 7 women and 13 boys so that 2 men receive as much as 5 boys, and 2 women as much as 3 boys, how much will each man, woman and boy receive?

19. How many revolutions will be made by a wheel which revolves at the rate of 329 revolutions in 3 min. while another wheel revolving 431 times in 4 min makes 2586 revolutions?

20. If a train goes $22\frac{1}{2}$ miles an hour, how many revolutions does the driving-wheel, 11 ft. in circumference, make in a second?

21. A game licence costs 15*s*, and a cartridge 2*d.* A sportsman kills his bird once in 5 shots. If birds are worth 2*s*. 6*d.* a brace, how many birds must be shot just to pay expenses?

22. A vulgar fraction has for its numerator 157, and its nearest approximate value in hundredths is ·37; what is the denominator?

23. A man after a tour in England finds that he had spent every day half as many rupees as the total number of days he had been from home. His tour cost R1800. How many days did it occupy?

24. A plate of metal is beaten to the thickness of $\frac{1}{8}$ of an inch, and the weight of a circular medal cut from it, whose diameter is $1\frac{1}{8}$ inches, is $1\frac{1}{4}$ oz. troy. If the same plate be beaten to the thickness of $\frac{1}{6}$ of an inch, what will be the weight of a medal cut out of it of the diameter of $1\frac{1}{4}$ inches (the areas of circles being proportional to the squares of their diameters)?

25. It is said that 240,000 letters are posted in Berlin daily, 16·6 per cent. of which are town letters. This gives one letter for every 2 persons in Berlin; what is its population?

26. The French unit of linear measure is a *metre* equal to 39·371 English inches; the square formed on a line of 10 metres (called an *are*) is the French unit of surface. Find the equivalent, in English square measure, of a hectare (100 ares).

27. A rectangular swimming bath is 60 ft. long and 40 ft. broad; it can be filled by a supply-pipe in 5 days, and if 6,000 cubic feet of water be thrown in, the rest can be filled in 3 days 18 hours. Find the depth of the bath.

28. The debts of a bankrupt amount to R21345. 4*a* and his assets consist of property worth R9167. 10*a* 8*p*. and an undiscounted bill of R5130 due 4 months hence, simple interest being reckoned at 4 p. c. per annum. How much in the rupee can he pay his creditors?

29. The diameter of the fore-wheel of a carriage is $1\frac{7}{8}$ ft. and that of the hind-wheel is 3 feet; how far will the carriage have travelled when the fore-wheel has made 100 more revolutions than the hind-wheel? (The circumference of a circle : diameter :: 3·1416 : 1.)

30. Tea at 4*s.* $3\frac{1}{2}$*d.* per lb. is mixed with tea at 3*s.* $7\frac{1}{2}$*d.* per lb. so that the mixture contains 72 per cent. of the former. Find the weight of a chest of this mixture which is worth £6. 16*s.* 10*d.*

31. A merchant buys China tea at 3*s.* 6*d.* per lb. To improve the flavour he adds 2 oz. of Assam tea to every lb. of China tea, and finds that the mixture costs him 4*s.* per lb. How much per lb. did he give for the Assam?

32. Standard silver, of which 111 parts in 120 are pure silver, being worth ₨31 per lb., find the value of a Sicca Rupee which weighs 7 dwt. 12 gr. and has a fineness of 979 parts in 1000.

33. A contract is to be finished in 5 months and 17 days, and 43 men are put on to work at once; at the end of $\frac{2}{3}$ of the time it is found that only $\frac{1}{4}$ of the work is done; what extra number of hands will be required to complete the contract in the given time, the last employed men to work 12 hours a day, whilst the first 43 men work until the contract is completed only 10 hours a day?

34. A man can do as much work in 4 hours as a woman in 6 hours, or as a boy in 9 hours; how long will it take a boy to complete a piece of work, one-half of which has been done by a man working 10 hours and a woman working 16 hours?

35. If a piece of cloth, 4 yd. long and 15 in. wide, cost ₨3. 2*a*, how much should you give for another piece, 19 yd. long and 12 in. wide, every sq. in. of which is worth $\frac{2}{3}$ of the value of a sq. ft. of the former?

36. A person sets out to walk 26 miles; for a quarter of the distance he goes at the rate of 5 miles an hour, for half the remaining distance at 4 miles an hour and 3 miles an hour for the other half. State the exact time occupied in the journey.

37. How often between 12 and 1 are the hands of a clock an integral number of minute-spaces apart?

38. Two clocks begin striking the hour of noon together on a certain day, the interval between every two strokes being 1″ and 2″ respectively. They gain 1″ and 2″ respectively in every 24 hours. After what length of time will they end striking the hour of noon together?

39. *A* and *B* start at the same time on a journey. *A* walks at the rate of 4 miles an hour, and *B* of 3 miles an hour. When *A* has gone half way, *B* gets a ride and goes at twice the rate of *A*, until he has ridden a distance equal to $\frac{8}{15}$ of the whole journey beyond the spot at which he passes *A*. *B* then walks the remainder of the journey, *A* having walked it all. Will *A* or *B* arrive first? And what fraction of the whole journey will the other still have to travel?

40. If 15 men can dig 600 cu. ft. of earth in 5 days, working

8 hours a day, how many men would be required to dig 1575 cu. ft. in 14 days, working 9 hours a day, supposing that a man who works 8 hours a day does in 25 hours the same amount of work that a man who works 9 hours does in 26?

41. If 21 horses and 217 sheep can be kept 10 days for the same sum as it would cost to keep 9 horses and 60 sheep for 27 days, find how many sheep eat as much as 3 horses.

42. If running a four-mile race on a course half a mile round, *A* overlaps *B* at the middle of the 6th round. By what distance will *A* win?

43. *A* and *B* start to run a race at 3 o'clock. The winner comes in at $6\frac{3}{4}$ minutes past 3, beating the other by 40 yards. At 4 minutes past 3 the loser was 1140 yards from the winning-post. Find the length of the course, and the speed of the winner in miles per hour.

44. Five men do $\cdot 600\dot{6}$ of a piece of work in $2\cdot 12$ hours, how long will 6 boys take to finish it, it being known that 3 men and 7 boys have done the whole of a similar piece of work in 3 hours?

45. If 4 men earn as much in a day as 7 women, and one woman as much as 2 boys, and if 6 men, 10 women and 14 boys working together for 8 days earn £22, what will be the earnings of 8 men and 6 women working together for 10 days?

46. The distance by Railway from Madras to Salem is $206\frac{3}{4}$ miles. A Passenger Train travelling 20 miles an hour leaves Madras at 7 A. M.; and a special Train at 10 A. M. the same day. At what rate must the latter travel, so as just to overtake the former at Jollarpett Junction (132 miles from Madras), and at what hour must a Goods Train leave Salem for Madras travelling 15 miles an hour, so as to reach Jollarpett at the same time as the other Trains?

47. Two trains measuring 330 ft. and 264 ft. respectively, run on parallel lines of rail. When travelling in opposite directions they are observed to pass each other in 9 seconds, but when they are running in the same direction at the same rates as before the faster train passes the other in $27\frac{1}{2}$ seconds. Find the speeds of the two trains in miles per hour.

48. A man near the sea-shore sees the flash of a gun fired from a vessel, steaming directly towards him, and hears the report in 15″. He then walks towards the ship at the rate of 3 miles an hour, and sees a second flash 5 minutes after the first, and immediately stops; the report follows in 10½″. Find the rate of the ship, the velocity of sound being 1200 feet per second.

49. A soldier has 4 hours' leave of absence; how far may he ride on a coach which travels 8 miles an hour, so as to return to the camp in time, walking at the rate of 4 miles an hour?

50. Two trains start at the same time, the one from Calcutta to Allahabad, the other from Allahabad to Calcutta. If they arrive at Allahabad and Calcutta respectively 5 hours and 20 hours after they passed each other, show that one travels twice as fast as the other.

51. A cistern is provided with two pipes, A and B. A can fill it in 20 minutes, and B can empty it in 30 minutes. If A and B be kept open alternately for one minute each, how soon will the cistern be filled ?

52. A, B, C are pipes attached to a cistern. A and B can fill the cistern in 20 and 30 minutes respectively, while C can empty it in 15 minutes. If A, B, C be kept open successively for one minute each, how soon will the cistern be filled ?

53. A train having to perform a journey of 150 miles, is obliged after 100 miles to reduce its speed by one-fifth. The result is that the train arrives at its destination half an hour behind time. What is its ordinary rate ?

54. A down Passenger Train, 176 yd. long, travelling at the rate of 20 miles an hour, meets at 7 A. M. an up Goods Train, $293\frac{1}{3}$ yd. long, and passes it in 24 seconds. At 7-30 A. M. the down Passenger meets the up Mail, 88 yd. long, and passes it in 12 seconds. When will the Mail overtake the Goods ?

55. A and B start together from the same point on a walking match round a circular course. After half an hour A has walked 3 complete circuits, and B four and a half. Assuming that each walks with uniform speed, find when B next overtakes A.

56. A certain sum is to be divided among A, B and C. A is to have £30 less than the half, B is to have £10 less than the third part, and C is to have £8 more than the fourth part. What does each get ?

57. £4212 is divided among A, B, C, so that A receives $\frac{4}{9}$ as much as B and C together, and B $\frac{1}{3}$ of what A and C together receive. Find how much each receives.

58. Two-thirds of a certain number of persons received 18*d.* each, and one-third received 2*s.* 6*d.* each. The whole sum spent was £2. 15*s.* How many persons were there ?

59. A crew which can pull at the rate of 9 miles an hour, finds that it takes twice as long to come up a river as to go down : at what number of miles an hour does the river flow ?

60. A, B, C are partners : A whose money has been in the business for 4 months claims $\frac{1}{8}$ of the profits : B whose money has been in the business for 6 months claims $\frac{1}{3}$ of the profits : C had Rs1560 in the business for 8 months : how much money did A and B contribute to the business ?

61. Two persons A and B rent a field. A puts on it 12 horses for $2\frac{1}{3}$ months, 20 cows for 4 months and 50 sheep for 5 months; B puts 18 horses for $3\frac{1}{2}$ months, 15 cows for 5 months and 40 sheep for $4\frac{1}{2}$ months. If in one day 3 horses eat as much as 5 cows, and 6 cows as much as 10 sheep, what part of the rent should A pay?

62. A can dig a trench in $\frac{1}{2}$ the time that B can; B can dig it in $\frac{2}{3}$ of the time that C can; all together they can dig it in 6 days. Find the time it would take each of them alone.

63. For 5 guineas can be obtained either 12 lb. of tea and 15 lb. of coffee, or 36 lb. of tea and 9 lb. of coffee; find the price of a pound of each.

64. Divide 48 into two parts such that if one part be multiplied by 3 and the other by 5, the sum of the products shall be 180.

65. Divide 20 into two parts such that three times one part may be equal to twice the other part.

66. A decimetre is equal to 3·937 inches, and a cubic decimetre of water weighs 1 kilogram. If a cubic inch of water weighs 252·45 grains, express a kilogram in pounds avoir. correct to two decimal places.

67. Twenty gallons of liquid contain 60 per cent. of nitric acid and the rest water. How many gallons of water should be added to the mixture to lower the proportion of nitric acid to 40 per cent?

68. Divide R1000 among 1 man, 3 women and 36 children so that the man gets 4 times as much as each woman, and the women together get 12 times as much as each child.

69. Two men undertake to do a piece of work for R40. One could do it alone in 5 days, the other in 8 days. With the help of a boy they finish it in 3 days. How should the money be divided?

70. The sum of the ages of A and B is now 55 years, and their ages 10 years ago were as 4 is to 3; find the present ages.

71. A tradesman's prices are 20 p. c. above cost price; what profit does he make, if he allows his customers a discount of a penny in the shilling?

72. Four apples are worth as much as 5 plums, 3 pears as much as 7 apples, 8 apricots as much as 15 pears, and 5 apples sell for 2*d*. I wish to buy an equal number of each of the four fruits, and to spend an exact number of pence: find the least sum I can spend.

73. The manufacturer of an article makes a profit of 20 per cent., the whole-sale dealer, of 10 per cent., and the retail dealer, of 5 per cent. what is the cost of the manufacture of an article which is retailed for R7. 8*a*. 9*p*.?

74. Two cogged wheels, of which one has 16 cogs and the other 20, work in each other. If the latter turns 60 times in $\frac{3}{4}$ of a minute, how often does the former turn in 16 seconds?

75. The price of butter having risen 25 p. c., the daily allowance of each person in a family is reduced from 1 oz. to $\frac{7}{8}$ oz. If the monthly charge for butter is thenceforward 12*s*., what was it before the changes were made?

76. A bankrupt has book-debts equal in amount to his liabilities, but on £4000 of them he can recover only 15*s*. in the £, and the expenses of the bankruptcy are £200; if he pay 15*s*. $2\frac{2}{3}$*d*. in the £, what is the amount of his liabilities?

77. A ship 40 miles from the shore springs a leak which admits $3\frac{3}{4}$ tons of water in 12 minutes. 60 tons would suffice to sink her, but the ship's pumps can throw out 12 tons of water in an hour. Find the average rate of sailing so that she may reach the shore just as she begins to sink.

78. Standard silver is formed by mixing 11 parts of fine silver with one of copper. How many rupees can be coined from 1 lb. avoir of fine silver, if 1 lb. troy of standard silver is coined into 32 rupees

79. If $2\frac{1}{4}$ tolas of gold, 22 carats fine, be worth ₨49. 8*a*., of what fineness must gold be in order that $1\frac{1}{2}$ tolas of it may be worth ₨34. 8*a*.?

80. A man having to walk 36 miles finds that in 3 hr. 20 min. he has walked $\frac{5}{7}$ of the remaining distance; find his speed.

81. Supposing the alloy in a rupee to be $\frac{1}{12}$ of the mass, and the coin to be worth 2 pice if it were all alloy, what would [illegible] exact value if it were all pure silver?

82. A mixture contains wine and water in the ratio of 3 : 2; if it contains 3 gallons more wine than water, what is the quantity of wine in the mixture?

83. 3 men [illegible] do 4 times as much work as a man and a boy can [illegible] time. Find the ratio of the works [illegible]e by a [illegible] same time.

84. A [illegible] of 4 parts brandy and 1 part water; [illegible] of water is added, and the mixture contains 3 times as [illegible]andy as water: find the quantity of brandy in the mixture.

85. A mixture contains wine and water in the ratio of 3 : 2, another contains wine and water in the ratio of 4 : 5: how many gallons of the latter must be mixed with 3 gallons of the former that the resulting mixture may contain equal quantities of wine and water?

86. A, B and C are three vessels holding 1, 2 and 4 gallons respectively. A is empty, B is full of water and C is full of wine. A is filled from B, B is replenished from C, and then A is emptied into C. When this operation has been performed once more, what will be the ratio of the wine in B to the water in C?

87. An alloy of silver is mixed with an alloy of gold in the ratio of ·73 to ·37; the quantity of dross in the silver alloy is 12 parts in 100, and in the gold alloy 15 parts in 100: compare the quantities of gold, silver and dross in the mixture.

88. A barters some sugar with B for flour which is worth 2*s.* 3*d.* per stone, but uses a false stone weight of 13½ lb; what value should B set upon his flour, that the exchange may be fair?

89. If the work done by a man, a woman, and a child be in the ratio of 3, 2, 1, and there be in a factory 24 men, 20 women and 16 children, whose weekly wages amount to R224, what will be the yearly wages of 27 men, 40 women and 15 children?

90. A [illegible] lb. of tea and 3 lb. of sugar cost R3, but if sugar rose 50 per cent. and tea 10 per cent., they would cost R3. 8*a.*; find the prices per lb. of tea and sugar.

91. A bankrupt has goods worth R9750; and had they realised their full value, his creditors would have received 13 annas in the rupee; but $\frac{2}{5}$ths were sold at 17·5 p. c., and the remainder at 23·75 p. c., below this value. What sum did the goods fetch, and what dividend was paid?

92. Gold is sold at the Mint at £3. 17*s.* 9*d.* per oz. and is mixed with alloy, worth 5*s.* 2*d.* per oz., in the ratio of 11 : 1. If sovereigns be coined of this mixture, each weighing 5 dwt. 3·47 gr., what is the Mint profit per 100 sovereigns?

93. A bag contains 160 coins consisting of half-crowns, shillings, sixpences and fourpences, and the values of the sums of money represented by each denomination of coin are the same; how many of each are there?

94. In sending 100 cheroots to England I paid freight $\frac{3}{8}$ of their prime cost; landing charges $\frac{1}{4}$ of their cost including freight; and duty 2½ times their cost including freight and landing charges. Altogether the cheroots, duty paid, in London cost me £7. What did I give for them in Madras?

95. A number of rupees is divided amongst four men. A receives $\frac{3}{8}$ of the whole, B $\frac{1}{4}$ of the remainder, C $\frac{1}{5}$ of what then remains, and the number of rupees given to D is the square root of the whole number to be divided. What sum does each receive?

96. For $\frac{2}{3}$ of the distance up a ghaut the rise is 1 foot in 24 (measured along the road) and for the remaining third the rise is 1 in 16. The top of the ghaut is 1,400 ft. above the bottom; what is its length?

97. In a company of 100 people, of whom some are rich and some are poor, the rich subscribe and give 1*a*. 3*p*. to each poor man; this costs the rich men 7*a*. 1*p*. each: how many rich and how many poor men are there?

98. Given that gold is worth £3. 17*s*. 10*d*. per oz., and silver 4*s*. 10*d*. per oz, and that the weights of equal volumes of gold and silver are as 19 : 11; find the volume of silver equal in value to a cubic inch of gold.

99. A tradesman bought a quantity of goods, and sold $\frac{2}{3}$ of them at a profit of 10 p. c; the price rising, he got $12\frac{1}{2}$ p. c. profit on the remainder, and on the whole gained ₨425: what sum did he lay out?

100. A publican buys two butts of wine, one for ₨1200, and one for ₨1100; he also buys a third and after mixing the three, retails the wine at ₨22. 8*a*. a dozen, making $12\frac{1}{2}$ p. c. on his outlay: supposing the number of dozens in a butt to be 52, find the price of the third butt.

101. A merchant sells 49 quarters of wheat at a profit of 7 p. c, and a certain number of quarters at a profit of 11 p. c. The cost price of a quarter of wheat being £3. 12*s*. 6*d*., he would have lost £2. 10*s*. 9*d* if he had sold the whole at a profit of 9 p. c. Find the total number of quarters of wheat sold by him.

102. The shares in a banking concern are ₨1000 each, ₨426. $10\frac{2}{3}$*a*. are only paid up, and the shares are quoted in the market at ₨460. The dividend is ₨$7\frac{1}{2}$ per share quarterly. A gentleman holds 100 original shares. Find what interest he makes per cent.; and how much per cent. would he make, if he sold out and invested in 4 per cent. Govt. stock at par?

103. A person finds that if he invest a certain sum in railway shares paying £6 per share when the £100 share is at £132, he will obtain £10. 16*s*. a year more for his money than if he invest in 3 per cent. consols at 93. What sum has he to invest?

104. A person has ₨24,180 to invest; the $5\frac{1}{2}$ per cent. Govt. loan being at 108 and the 6 per cent. Municipal loan of ₨1,000 being at 1020; find how he must divide his capital between the Govt. and Municipal loans, that he may obtain the same income from each.

105. A railway proprietor receives one year a dividend of 6 per cent. on his stock, and pays an income-tax of 4*d* in the £. The next year he receives a dividend of $6\frac{1}{2}$ per cent. and pays an income-tax of 3*d*. in the £, and finds that his net income is £249 more. How much railway stock does he hold?

106. A man sold at 48 and 95 respectively £500 ordinary stock in the *A* Railway paying a dividend at the rate of $1\frac{3}{4}$ and £800

preference stock in the *B* Railway paying a dividend of 4 per cent. He then invested $\frac{1}{4}$ of the money in the Tramway Company where the £24 share paying interest at 6 per cent, was at £6 premium; £150 in the *C* Railway which paid no interest; and the remainder in Bank shares at par: what rate of interest must he receive from the Bank in order to increase his annual income by £12. 5*s*.?

107. There are two railway engines whose rates of motion may be represented by 1 and ·75. Supposing the slower to have been 12 miles in advance of the faster train on the same line, how far would the faster train have to travel before it overtook the other?

108. The value of 1 lb. of gold is 20 times that of 1 lb. of silver and the weights of equal volumes of gold and silver are as 19 : 10; find the value of a bar of silver equal in bulk to a bar of gold of value £380.

109. A merchant owes a bill of R5,795, payable in 8 months and another of R7,822, payable in 12 months; he takes up these two bills and gives in their place one for R13,716, payable in 12 months: what is the rate of interest per cent. per annum?

110. A Calcutta merchant has to pay R10,512. 8*a*. to his agent in Bombay. What must he give for a bank draft to that amount, exchange being at 100$\frac{1}{4}$?

111. A man bequeaths his property amounting to R49,166 in such a way that $\frac{1}{4}$ of his wife's share, $\frac{2}{5}$ of his eldest son's, $\frac{3}{7}$ of his younger son's and $\frac{1}{6}$ of his daughter's share are all equal. Find the share of each.

112. *A* and *B* exchange goods; *A* gives 13 cwt of hops, the retail price of which is 56*s*. per cwt. but in barter he rates them at £3. *B* gives 10 barrels of beer, the retail price of which is 1*s* a gallon, but the value of which he raises in proportion to the increased price of the hops. How much must *B* give in money?

113. A person having to pay R10,572 two years hence, invests in the 4 per cent. Transfer Loan to accumulate interest till the debt shall be paid, and also an equal sum the next year. Supposing the investment to be made when paper is at 86$\frac{1}{4}$, and the price to remain the same, what sum must be invested on each occasion that these may be just sufficient to pay the debt at the given time?

114. A train has been travelling 20 miles an hour: the steam power is doubled, whilst from various causes the resistance of the train is increased by one-half (The original steam power is three times the resistance). At what rate will the train now travel?

115. A sailing vessel reaches Madras from Calcutta in 6 days; a steamer whose speed is to that of the sailing vessel as 3 : 2 starts at the same time, but meets with detentions that average 6 hours daily. Which will reach Madras first? And by how much?

116. A book containing between 900 and 1000 pages is divided into four parts. each part being divided into chapters. The whole number of pages in each of the four parts is the same. Each chapter in the first part contains 20 pages, each chapter in the second 40, each chapter in the third 60, and each chapter in the fourth 80. Find the whole number of chapters in the book.

117. A person buys a piece of land at £25 an acre, and by selling it in allotments find that the value is increased by one-half, so that, after reserving 20 acres for himself, he clears £200 on his purchase money by the sale of the remainder. How many acres were there?

118. Find how much rice a family requires monthly, when a reduction in the price from 7 to 10 measures for the rupee reduces the total monthly expenses from ₨$31\frac{1}{2}$ to ₨30.

119. *A* barters sugar with *B*. for rice which is worth $1\frac{7}{8}$ annas a measure, but in weighing his sugar uses a false maund weight. *B* discovers this, and to make the exchange fair raises the price of his rice to $2\frac{1}{8}$ annas a measure. Find the real weight of the false maund which *A* uses.

120. A person pays an income-tax of 4*d*. in the £ during the first half of the year and of 3*d*. in the £ during the second half, and finds that owing to an increase in his income he pays the same amount of tax for the second as for the first half of the year. If his gross income for the year is £700, find his net income.

121. The materials of an old building were sold for ₨1,500 upon condition that they should be removed within 30 days under a penalty of ₨10 per day for every day beyond 30 days. The purchaser employed 40 men at $3\frac{1}{2}$ annas per day to do the work, and after selling the materials for ₨2365, he cleared ₨190 by his bargain. Find the number of days the men were at work.

122. *A* and *B* enter into partnership; *A* supplies the whole of the capital, amounting to ₨45,000 upon condition that the profits are to be equally divided, and that *B* pays *A* interest on half the capital at 10 per cent. per annum but receives ₨120 per mensem for carrying on the concern. Find their total yearly profits when *B*'s share is equal to $\frac{1}{2}$ of *A*'s share.

123. If the value of a rupee varies from 1*s*. 9*d*. to 1*s*. $9\frac{1}{2}$*d*. and of the franc from $9\frac{1}{2}$*d*. to 10*d*.; find the maximum number of francs which it is always safe to give for ₨500.

124. If the volume of a sphere $= \frac{4}{3} \times 3{\cdot}1416 \times$ the cube of the radius, find how many spherical balls each $\frac{1}{2}$ inch in diameter can be made out of a cubic inch of clay, and how much clay will remain over.

125. Paper-money is at a discount of 10 per cent. A man buys goods marked £27 (paper-money) and offers that sum in gold. How

much paper-money must he receive in change, 10 per cent. abatement being allowed for cash ?

126. A reservoir is to be emptied, the rate of discharge of the contents being diminished by 100 gallons every hour. The first half will be emptied in 3 hours, the second in 4 hours. How many gallons does the reservoir contain ?

127. What must be the least number of soldiers in a regiment to admit of its being drawn up 2, 3, 4, 6 or 8 deep, and also of its being formed into a solid square ?

128. *A*, *B* and *C* are partners. *A* receives $\frac{2}{3}$ of the profits, *B* and *C* dividing the remainder equally *A*'s income is increased by R400 when the rate of profit rises from 5 to 7 per cent. Find the capital of *B*.

129. How many year's purchase should be given for an estate so as to get 4 per cent. for the money ?

130. An agent has to receive a rent paid in corn from a tenant, and to deliver it to the landlord. At each payment he uses, so as to benefit himself, a false balance, such that 4 seers in one scale balance 5 seers in the other. Corn being worth R2. 8*a*. a md, the value of his plunder is R4. What is the corn-rent ?

131. A zemindary is bought at 20 years' purchase for R27000, one-third of the purchase-money remaining at mortgage at 9 per cent. The cost of collecting rents is R140 per annum. What interest does the purchaser make on his investment ?

132. A baker's outlay for flour is 70 per cent. of his gross receipts, and other trade expenses amount to $\frac{1}{8}$ of his receipts. The price of flour falls 50 per cent., and other trade expenses are thereby reduced 25 per cent By how much should he now reduce the price of a 5*d*. loaf to make the same amount of profit ?

133. 1000 copies of a pice newspaper weigh $\frac{1}{2}$ of a maund, and when the paper duty was removed the profit on the receipts was increased 5 per cent. What was the duty per md. on paper ?

134. A horse was sold at a loss of 10 p. c. ; if it were sold for R70 more there would have been a gain of 4 per cent. : for how much was the horse sold ?

135. A contractor sends in a tender of R7000 for a certain work ; a second sends in a tender of R6950, but stipulates to be paid R3000 at the end of a month ; find the difference between the tenders, supposing the work to be finished in 3 months, and money to be worth $\frac{1}{2}$ per cent. per month simple interest.

136. A labourer was engaged for 20 days, on the agreement that for every day he worked he should have 4*a*., but that for every day he absented himself he would be fined 1*a* He received R2. 13*a*., at the end of the time : how many days was he absent ?

137. A man was hired to do a certain amount of work, on the condition that for every day he worked he should have 12*a*., but that for every day he absented himself he should lose 4*a*. He worked 3 times as many days as he absented himself, and received on the whole R10. How long was he doing the work?

138. A grocer buys two maunds of sugar; he sells one maund at a profit of 10 p. c., and the other which cost R2. 8*a*. more, at a profit of 15 p. c. If the retail price per seer of the latter be $1\frac{3}{10}$*a*. more than that of the former, find the cost price of each maund.

139. A shop-keeper buys 2 md. of sugar, and 1 md. more of a superior kind, giving R1. 8*a*. a md. more for the latter than the former. He retails it, when mixed, at 4 annas a seer, and makes a profit of 25 p. c. on his outlay. What did he give per md. for each kind of sugar?

140. Two boys begin to count two equal piles of rupees. One counts 5 while the other counts 4. When the former has just finished the latter has 6 left. What is the number of rupees in each pile?

141. The price of a yard of jean is $\frac{3}{8}$ of the price of $2\frac{1}{2}$ yd. of longcloth; and the weight of 5 yd. of jean is $\frac{5}{8}$ of the weight of 8 yd. of longcloth. If the price of 2 lb. of jean be R3, what is the price of $1\frac{1}{2}$ lb. of longcloth?

142. Three tramps meet together for a meal: the first has 5 loaves, the second 3, and the third, who has his share of the bread, pays the other two 8 half-pence; how ought they to divide the money?

143. *A* and *B* barter: *A* has 7 md. of flour worth R3. 8*a*. a md., but insists on having R3. 12*a*, a md.: *B* has rice worth R1. 5*a*. a measure, which he raises in price in proportion to *A*'s demand. *A* receives 16 measures of rice: what cash does he get besides?

144. *A* and *B* barter: *A* has 200 lb. of tea worth 2*s*. 6*d*. a lb. but insists on 2*s*. 9*d*. a lb.: *B* has coffee worth 1*s*. 9*d*. a lb.: how much must he raise the price so that *A* gets £5. 2*s* and 2 cwt. of coffee?

145. A river 14 ft. deep. 182 yd. wide flows at the rate of 3 miles an hour; (i) how many tons, (ii) how many gallons of water, pass a certain point per minute? [A cu. ft. of water weighs $62\frac{1}{2}$ lb.; a gallon contains $277\frac{1}{4}$ cu. in.]

146. A four-wheeled carriage travels round on a circular railway. The circumferences of the two wheels of the carriage and of the two circles of rails are proportional to 6, 7, 7000, 7014. Find the number of revolutions made by each of the four wheels in a complete circuit?

147. Eleven boys fired 10 shots each at a target, and scored

286 ; 20 bull's-eyes were made and 11 misses ; how many centres and outers were there? (A bull's-eye scores 4, a centre 3, an outer 2).

148. The sum of £177 is to be divided among 15 men, 20 women and 30 children, in such a manner that a man and a child may receive together as much as two women, and all the women may together receive £60 : what will they each respectively receive?

149. *A* owed *B* three-fourths of what *B* owed *C*; to settle matters, *B* gave R2 to *A* who then paid *C*; what did *B* owe *C*;

150. A man for 4 years spends R500 a year more than his income. At the end of that time, he reduces his expenditure 30 per cent. and in 3 years pays off his debt and saves R1000. What is his income?

151. A tree grows 2 yards in its first year, and afterwards it grows each year 1 foot less than it did the previous year. The value of the tree at any time is equal to the number of rupees in the square of the number of yards in its height; find the value of the tree when it has done growing.

152. If standard gold, worth £3. 17*s*. 10½*d*. per ounce be so far alloyed as to be worth only £3. 16*s*. 1½*d*. per ounce, find the least integral number of sovereigns made of the alloyed gold, which shall be equal in value to an exact number made of the standard gold.

153. Find the least integral number of ounces of pure silver, worth R2. 14*a*. $6\frac{6}{11}$*p*. per ounce, that, with the proper proportion of alloy, can be coined into an exact number of rupees.

154. Mahogany is 50 lb. to the cubic foot, water is 62½ lb., and iron is 7½ times as heavy as water; what thickness of iron will weigh as much as a 6 inch plank of mahogany?

155. A sum of R62 is to be divided among 10 men, 15 women, 8 boys and 12 girls. For every rupee that a man gets, a boy gets 6 annas, and for every half-rupee that a woman gets, a girl gets 2 annas. The whole money obtained by the boys is equal to that obtained by the girls. How much does each person get?

156. A wooden closed box, made of ½-inch plank, is externally 15 in. long, 10 in. broad and 6 in. high. The box weighs 6 lb. when empty, and 85 lb. when filled with mercury. Compare the weights of equal bulks of the wood and mercury.

157. R430 is divided among 45 persons consisting of men, women and children. The sums of the men's, women's and children's shares are as 12 : 15 : 16, but the individual shares of a man, woman and child are as 6 : 5 : 4. Find the number of men, women and children.

158. Bronze contains 91 per cent. of copper, 6 of zinc, and 3

of tin. A mass of bell-metal (consisting of copper and tin only) and bronze fused together is found to contain 88 per cent. of copper, 4·875 of zinc, and 7·125 of tin. Find the proportion of copper and tin in bell-metal.

159. An alloy contains 12 parts by weight of lead, 4 of antimony, and 1 of tin. How much of this alloy must be taken, and how much lead and tin added to it to make up 9 cwt. of type-metal consisting of 14 parts lead, 3 antimony and 1 tin?

160. Three persons *A*, *B*, *C*, finished a piece of work. *A* worked at it for 5 days, *B* for 7 days and *C* for 9 days. Their daily wages were as 4 : 3 : 2, and the total earnings amounted to ₨7. 6*a*. What were the daily wages of each?

161. Two passengers are charged for excess of luggage ₨1. 8*a*. and ₨5. 4*a*. respectively. Had the luggage all belonged to one person he would have been charged ₨7. 8*a*. for excess. How much is allowed free, the charge of excess being 12*a*. per md.?

162. If the cost of making bread be one rupee per bushel of wheat, what is the price of wheat when the two-anna loaf is twice as large as it is when wheat is ₨5 a bushel?

163. If the rate of wages vary as the price of rice, and if 57 men working for 35 days receive ₨405. 3*a*. 9*p*. when rice is sold at the rate of 136 measures for ₨39; find the price of rice per measure when 70 men working for 19 days receive ₨353. 4*a*. 6*p*.

164. There is a leak in the bottom of a cistern. When the cistern was in thorough repair, it would be filled in $2\frac{1}{3}$ hours. It now takes half an hour longer. If the cistern is full, how long would it be in leaking itself empty?

165. *A* can do $\frac{2}{3}$ of a piece of work in $\frac{4}{5}$ of the time in which *B* can do $\frac{1}{4}$ of it, and *B* can do $\frac{3}{4}$ of it in $\frac{2}{3}$ of the time that it would take *C* to do another piece of work one-fourth as large again as the first. If *C* can finish the former piece of work in 10 hours, how long would it take *A* and *B* together to do it?

166. *A* and *B* start on a journey at the same time. *B* travels at $\frac{4}{7}$ of *A*'s rate, and arrives 3 hr. 15 min. after him. In what time did each complete the whole journey?

167. The expenses of a family when rice is at 20 seers for a rupee are ₨50 a month; when rice is at 25 seers for a rupee the expences are ₨48 a month; what will they be when rice is at 30 seers for a rupee?

168. A man who can walk down a ghaut at the rate of $4\frac{1}{2}$ and up it at the rate of $3\frac{3}{4}$ miles an hour, descends and returns to his starting point after walking for 2 hours 4 minutes. How far did he walk?

169. An express train owing to a defect in the engine goes at

$\frac{5}{8}$ of its proper speed, and arrives at 6-49 P. M. instead of 5·55 P. M.; at what hour did it start?

170. A person going from Pondichery to Ootacamond travels 90 miles by steamer, 330 miles by rail and 30 miles by horse-transit. The journey occupies 30 hr. 50 min., and the rate of the train is 3 times that of the horse-transit and $1\frac{1}{2}$ times that of the steamer. Find the rate of the train.

171. A person walks from *A* to *B* at the rate of 3 miles an hour and after transacting some business which occupies him an hour, returns to *A* by the tramway at the rate of 5 miles an hour. He then finds he has been absent 2 hours 20 minutes. Find the distance from *A* to *B*.

172. The expenses of a family, when rice is 12 seers for a rupee, are ₨50 a month; when rice is 14 seers for a rupee, the expenses are ₨48 a month (other expenses remaining unaltered): what will they be when rice is at 16 seers per rupee?

173. A bankrupt has book-debts equal in amount to his liabilities, but on ₨8640 of such debts he can recover only $8\frac{1}{2}$ annas in the rupee, and on ₨6300 only $5\frac{1}{4}$ annas in the rupee. After allowing ₨1054. 11. 0 for the expenses of bankruptcy, he finds that he can pay his creditors 12 annas in the rupee. Find the total amount of his debts.

174. A train starts with a certain number of passengers. At the first station it drops $\frac{1}{3}$ of these and takes in 20 more. At the next it drops $\frac{1}{2}$ of the new total and takes 10 more. On reaching the third station there are 60 left. What number started?

175. One pound troy of standard silver which contains 37 parts in 40 of fine silver is coined into 66 shillings. If the value of pure silver rises 10 per cent., what must be the reduction of pure silver in a shilling?

176. A landlord has an estate worth ₨40000 a year, but has to pay $\frac{1}{2}$ anna in the rupee on the gross income for taxes. He sells it at 20 years' purchase on the gross income, and invests the proceeds in the 4 per cents. at 95. What is the difference in his income?

177. In firing at a mark *A* hits in 2 out of 4 shots, *B* in 3 out of 5, and *C* in 4 out of 7. The mark was hit 468 times. Supposing each to have fired the same number of shots, find how many hits each made and the total number of shots fired.

178. A shop-keeper buys sugar at ₨12. 8*a*. a md.; at what price must he sell it to gain 8 per cent., and allow a purchaser 10 per cent. discount?

179. In a manufactory 100 coolies work for 4 days a week, but on the remaining 3 days some are absent; the weekly wages of

the coolies are thus reduced in the ratio of 32 : 35. Find the number of absentees.

180. The manager of a boarding house having already 50 boarders, finds that an addition of 10 increases the gross monthly expenditure by R20, but diminishes the average cost per head by R1. What did the monthly expenses originally amount to ?

181. If 9 oz. of gold, 10 carats fine, and 5 oz., 11 carats fine, be mixed with 6 oz. of unknown fineness, and the fineness of the resulting mixture be 12 carats, what was the unknown fineness ?

182. A tradesman's stock in trade is valued on January 1st, 1868, at £8,000, he has also £350 in cash and owes £1,870 ; during the year his personal expenses, £300, are paid out of the proceeds of his business, and on January 1st, 1869, his stock is valued at £7,950, he has £570 in cash and owes £1,510. What is the whole profit on the year's transactions after deducting 5 per cent. interest on the capital with which he began the year ?

183. If 20 English navvies, each earning 3*s.* 6*d.* a day, can do the same piece of work in 15 days that it takes 28 foreign workmen, each earning 3 francs a day, to complete in 20 days ; taking the value of the franc at 10*d.*, determine which class of workmen it is most profitable to employ. If a piece of work done by the navvies cost £3,000, what would be the cost of the same work done by foreign workmen ?

184. A merchant in New York wishes to remit to London 5110 dollars, a dollar being equal to 4*s.* 6*d* English : for what sum in English money must he draw his bill when bills *on* London are at a premium of 9½ per cent. ?

185. A person borrows £100, and at the end of each year pays £25 to reduce the principal and to pay interest at 4 per cent. on the sum which has been standing against him through that year. How much will remain of the debt at the end of 3 years ?

186. If a metric system of area were adopted wherein 1 acre 1 rood 3 perches is represented by 5·12, express the unit of measurement in sq. yards and decimal parts of a sq. yd.

187. If gold weighs 19 times as much as water, and silver 12 times as much, find how many times heavier than water is a coin which contains 10 parts of gold and 1 of silver.

188. A certain reef of quartz when crushed yields ·0011 per cent. of gold. If the working expenses amount to 62·5 per cent. of the gross receipts, and the net profit on each 100 tons is £52. 10*s.*, find the number of grains in a sovereign.

189. A certain article of consumption is subject to a duty of 6*s.* per cwt ; in consequence of a reduction in the duty the consumption increases one-half, but the revenue falls one-third. Find the duty per cwt. after the reduction.

190. If the duty on a certain commodity were reduced 25 per cent., by how much per cent. must the consumption be increased that the same revenue may be derived from it ?

191. If 2 cu. in. of gold together with 3 cu. in. of silver are equal in weight to 74 cu. in. of water, and the weights of equal volumes of gold and water be represented by the numbers 19 and 1, what number represents the weight of an equal volume of silver ?

192. A farmer bought equal numbers of two kinds of sheep, one at £3 each, the other at £4 each. If he had expended his money equally in the two kinds he would have had 2 sheep more than he did ; find how many he bought.

193. A man travels 150 miles in 13 hours, partly by rail and partly by steamer ; if he had gone all the way by rail, he would have ended his journey 8 hours sooner, and saved $\frac{4}{5}$ of the time he was on steamer ; how far did he go by rail ?

194. In a distilling operation, during 3 hours the fluid contained 70 per cent. of alcohol, during $2\frac{1}{2}$ hours 60 per cent., and during the remaining $1\frac{1}{2}$ hours 40 per cent. What is the average strength of the whole fluid distilled over, assuming that it came over at a uniform rate during the whole time ?

195. During a distillation the fluid that comes over in 3 consecutive hours contains 47, 35 and 20 per cent of alcohol respectively. The rates at which it comes over during these 3 hours are in the ratios of 2, 3 and 4. What is the percentage of alcohol in the whole mixture ?

196. I bought a number of mangoes at 35 for R2. I divided the whole into two equal parts, one of which I sold at 17, and the other at 18 mangoes per R1. I spent and received an integral number of rupees, but bought the least possible number of mangoes How many did I buy ?

197. Find the cost in rupees of one mile of railway, which consists of two rails, each weighing 40 lb. per yard, on wooden sleepers, weighing 70 lb. each, placed 2 ft. 8 in. apart. The rails cost in England £6 . 13 . 0. per ton and the sleepers 2*s*. $4\frac{1}{2}$*d*. each. The rate of freight is £1 . 5 . 0. per ton, and landing charges amount to R2. 8*a*. per ton. Rate of exchange 1*s*. 8*d*. per rupee.

198. The length of the E. B. Railway being 110 miles and the capital employed in its construction 1500000*l*., what must be the gross annual trafic receipts per mile in order that a dividend of 5 per cent. may be paid to the share-holders after allowing 45 per cent. of the gross receipts for current expenditure ?

199. A person in India sells a bill on London for 35°*l*., payable at 3 months' sight at the rate of 1*s*. $10\frac{3}{8}$*d*. per rupee. The purchaser requires payment on presentation ; what amount does he receive after discount at 5 per cent. has been deducted ?

200. The Guernsey pound contains 18 oz. avoir., and the Guernsey shilling contains 13 English pence. If a Guernsey pound of butter cost 1*s* 6*d*., Guernsey money, what will be the price in English money of $2\frac{1}{2}$ lb. avoir.?

201. A contractor employs a fixed number of men to complete a work. He may employ either of two kinds of workmen: the first at 26*s*. 6*d*. per week each, the second at 18*s*. 6*d*. per week each; the work of the one of the former being to that of one of the latter as 5 to 4. If he finishes it as quickly as possible, he spends £270 more than he would have done if he had finished it as cheaply as possible, but takes 4 weeks less time. What would it have cost if he had employed equal numbers of the two kinds of workmen?

202. A manufactory turns out 50 tons of iron goods weekly, using up for that purpose 51 tons of iron at £6. 15*s*. per ton, 100 tons of coal at 11*s*. 6*d*. per ton, and £45 worth of other materials; rent, rates and taxes amount to £219 annually; wages and incidental expenses to £75 per week. At what price per cwt. must the iron be sold in order that the works may gain 8 per cent. per annum on a capital of £35000? [Reckon 52 weeks to the year]

203. Two lumps, composed of gold, silver and copper, together weigh 10 oz; one lump contains gold 75 p. c. and silver 15 grains per oz, the other contains gold 85 p. c. and silver 12 grains per oz. The total quantity of silver in the two lumps is 141 grains. If the two lumps are melted and formed into one, what per cent. of gold will it contain?

204. The only three creditors of an insolvent whose assets amount to £100 and who can pay only 5*d*. in the £, agree among themselves to take dividends in the proportion of the number of £, *s*. and *d*. respectively, contained in the amounts due to them. The dividends thus taken are in the proportion of 12 : 7 : 6. What are the amounts of their debts?

205. At an examination $\frac{1}{8}$ of a class gains $\frac{7}{8}$ of the maximum number of marks, $\frac{1}{16}$ gains $\frac{4}{5}$, $\frac{2}{5}$ gains $\frac{1}{2}$, $\frac{1}{4}$ gains $\frac{1}{4}$, and the rest $\frac{1}{8}$. The average number of marks gained by the whole class is 166; what is the maximum?

206. A mass of gold and silver weighing 9 lb. is worth £318. 13*s*. 6*d*.; if the proportions of gold and silver in it were interchanged, it would be worth £129. 10*s*. 6*d*.; it is known that 1 oz. of gold and 2 oz. of silver are worth £4. 8*s*. $1\frac{1}{2}$*d*.; what is the price of gold and silver per oz.?

207. A person shooting at a target, distant 550 yards, hears the bullet strike the target 4 seconds after he fires. A spectator, equally distant from the target and the shooter, hears the shot strike the target $2\frac{1}{2}$ seconds after he heard the report; find the velocity of sound.

208. A boatman rows 5 mi. with the tide in the time he would take to row 3 mi. against it; but if the hourly velocity of the current were $\frac{1}{2}$ a mile, he would row twice as rapidly with the tide as against it. Find his power of rowing in still water, and the velocity of the current.

209. A messenger sets out at the rate of 30 miles a day, but falls off in his speed 4 miles daily. Four days afterwards another sets off from the same place on the same route, travelling 50 miles the first day but falling off like the first 4 miles daily. After what time will one overtake the other?

210. Six months ago *A* invested £7620 in the 3 per cents. at $95\frac{1}{4}$, and six months hence he will receive £4300 four per cents. at 127. What is the present value of his property?

211. Two boats, *A* and *B*, row a race. *A* takes 4 strokes to *B*'s 5, but 6 of *B*'s are equal to 5 of *A*'s. *A* starts in front of *B* at such a distance that *B* must take 10 strokes to row over it. How many strokes must *B* take before overtaking *A*?

212. *A*, *B* and *C* run a mile race. *A* beats *C* by $76\frac{12}{23}$ yards; *B* beats *C* by 11 seconds; the pace of *A* is to that of *B* as 45 : 44. In what time does each run the mile?

213. Three boys begin to fill a cistern; one brings a seer every minute, another 2 seers every 2 minutes and the third 3 seers every 3 minutes. If the cistern holds 40 seers, in what time will it be filled?

214. *A* sells his goods 10 per cent. cheaper than *B*, and 10 per cent dearer than *C*; how much would a customer of *B* save by taking R100 worth of goods from *C*?

215. Cannons are fired at intervals of 10 minutes in a town towards which a passenger train is approaching at the rate of 35 miles an hour; if sound travels 1142 feet per second, find at what intervals the reports will be heard by the passengers.

216. A man bought a horse and a carriage for R500, and sold the horse at a gain of 20 p. c. and the carriage at a loss of 10 p. c., thus gaining 2 p. c. on his whole outlay; for how much was the horse bought?

217. If 3 men and 5 women do a piece of work in 8 days, which 2 men and 6 children, or 5 women and 3 children, can do in 12 days, find the relative strength of men, women and children.

218. Three round balls revolve with equal velocities in three concentric circular grooves. They start from a position in which they are all in the same radius of the outermost circle. The innermost ball occupies 10 seconds in traversing its groove once. After what time will they all be again on a radius of the outermost circle, the radii of the grooves being proportional to the numbers 1, 3, 5?

219. Two guns are fired at the same place after an interval of 21 minutes, but a person approaching the place observes that 20 min. 14 sec. elapse between the reports; what was his rate of progress, sound travelling 1125 feet per second?

220. Ash saplings after 5 year's growth are worth 1*s*. 3*d*., and increase in value 1*s* 3*d*. each year afterwards. For their growth they require each twice as many square yards as the number of years they are intended to grow before cutting. A plantation is arranged so that each year the same number may be ready for cutting. Find the greatest annual income which can be obtained per acre, allowing 20 per cent. for expenses.

EXAMINATION PAPERS.

I. UNIVERSITY OF CALCUTTA. ENTRANCE PAPERS.

1858.

1. Multiply R18957. 13*a*. by R568. $11\frac{3}{4}$*a*. ; and divide the same sum by the same sum. Shew that one of these operations is absurd and impossible and perform the other.

2. Find the value of the decimal ·16854, and deduce the rule arithmetically or algebraically.

3. Extract the square roots of 3 and of ·3 to 7 decimal places, and explain the rule that in integers the pointing off of the periods begins from the right hand, and in decimals from the left.

4. A plate of metal is beaten to the thickness of $\frac{1}{8}$ of an inch, and the weight of a circular medal cut from it, whose diameter is $1\frac{1}{8}$ inches, is $1\frac{1}{4}$ oz. Troy. If the same plate be beaten to the thickness of $\frac{1}{5}$ of an inch, what will be the weight of a medal cut out of it of the diameter of $1\frac{1}{4}$ inches (the areas of circles being proportional to the squares of their diameters) ?

1859, A.

1. What do you mean by a *prime number*, a *factor*, a *ratio* ? Resolve 30 and 132 into their prime factors, and find their ratio in its simplest terms.

2. How much muslin at R1. 5*a*. 8*p*. per yard is equal in value to 143 yards of the cambric at R3. 13*a*. 8*p*. per yard ?

3. Whether is the product of $2\frac{1}{4}$ and $3\frac{1}{6}$ or the product of $2\frac{1}{6}$ and $3\frac{1}{4}$ the greater ? Extract the square root of the difference.

4. If a person get a bequest of $\frac{5}{7}$ of an estate of 2,000 acres, and sell of his share, how many acres does he retain ?

Simplify the expression $\dfrac{1}{10+\dfrac{1}{2+\frac{1}{30}}}$.

5. Find, by Practice, the rent of 586 acres 1 rood 31 poles at £4. 1*s*. $10\frac{1}{2}$*d*. per acre.

6. A piece of land is 11·916 poles broad ; how long must it be to contain an acre ? Divide accurately 0·063 by 0·36.

7. How much must be paid for £1250 stock when it sells at 108 per cent. ?

1859, B.

1. A man can count at the rate of 100 a minute, how long will it take him to count five hundred lakhs ?

2. A shop-keeper purchased $250\frac{3}{4}$ yards of cloth for R900 and paid expenses amounting to R103: what must he charge per yard in order to make a profit of 50 per cent.?

3. Reduce ·005 of a pound to the fraction of a penny, and extract the square root of ·00006241.

4. Add together $\frac{2\frac{1}{2}}{3\frac{1}{4}}$, $\frac{1\frac{1}{4}}{3}$, 9 and $\frac{3}{4}$ of $\frac{5}{6}$ of $\frac{5}{8}$.

5. State the rules for pointing in multiplication and division of decimals: and multiply ·256 by ·0025 and divide ·0036 by ·4 and 4 by ·00001.

1860.

1. If the price of bricks depends upon their magnitude and if 100 bricks, of which the length, breadth and thickness are 16, 8 and 10 inches respectively, cost R2. 9*a*., what will be the price of 921600 bricks which are one-fourth less in every dimension?

2. Explain the method of pointing in extracting the square roots of whole numbers and decimals. Find the square root of 57,214,096 and also the square root of ·5 to four places of decimals.

3. Simplify $(1+\frac{5}{8}+\frac{7}{8}+1\frac{1}{2})\div(\frac{3}{4}-\frac{3}{8})$ and $\frac{7\frac{1}{2}}{6\frac{1}{2}}+\frac{11\frac{1}{2}-2\frac{3}{8}}{11\frac{1}{2}+2\frac{3}{8}}\times 10\frac{9}{14}-6\frac{4}{37}$.

4. A tea-dealer buys a chest of tea containing 2 maunds and 16 seers, at R4. 2*a*. per seer, and two chests more each containing 3 maunds and 24 seers, at R4. 10*a*. per seer: at what rate per seer must he sell the whole in order to gain 576 rupees?

1861.

1. Express as a decimal fraction $\frac{4\frac{3}{4}\times 8\frac{9}{11}}{\frac{5}{8}\div 10\frac{1}{2}}\times\frac{6\frac{1}{4}\text{ of }4\frac{4}{5}}{4+2\frac{1}{3}}$.

2. Reduce 3*s*. 6*d*. to the decimal of £5, and ·02$\frac{3}{4}$ to a vulgar fraction.

3. If an estate be worth £2,374. 16*s*. per annum, and the land-tax be assessed at 1*s*. 11$\frac{1}{2}$*d*. in the £, what will be the net annual income?

4. How much land may be rented for £1,716. 10*s*. 6*d*., if 3 acres are rented for £4. 13*s*. 4*d*.?

5. Extract the square root of ·00099856.

1862.

1. What is the difference between $\frac{4\frac{1}{2}}{5\frac{1}{4}}-\frac{99}{310}$ and ·06?

2. Reduce ·14 of a pie to the fraction of a rupee, and find the value of ·0875 of a pound sterling.

3. If the wages of 18 coolies for a month amount to R85 when rice is 24 seers per rupee, what ought the daily pay of a coolie to be in proportion when the price of rice is R2. 10*a*. 8*p*. per maund?

4. *A* and *B* run a race. *A* has a start of 40 yards, and sets off 5 minutes before *B*, at the rate of 10 miles an hour. How soon will *B* overtake him if his rate of running is 12 miles per hour?

5. Extract the square root of $\frac{1}{1000}$ to 5 places of decimals.

1863

1. Find the value in vulgar and decimal fractions of $\dfrac{15\frac{2}{3}+6-\frac{3}{4}}{7\frac{4}{9}\times\frac{5}{12}}$.

2. Find the fractional value of $(2\cdot37979+4\cdot22)\div(3\cdot041-\cdot937)$.

3. The weight of five casks of coffee being 31 cwt. 3 qr. 13 lb., calculate the price at 92 shillings per cwt.

4. If a man can perform a journey of 170 miles in $4\frac{1}{2}$ days of 11 hours each, in how many days of $8\frac{3}{4}$ hours will he perform a journey of 470 miles?

5. Extract the square root of 964·226704.

6. What sum of money will produce £43 interest in $3\frac{1}{4}$ years, at $2\frac{1}{2}$ per cent. simple interest?

1864.

1. How many paving stones, each measuring 14 in. by 12 in. are required to pave a verandah 70 ft. long and 9 ft. broad?

2. Add together $\frac{1}{3}$, $\frac{1}{7}$, $\frac{1}{11}$, $\frac{13}{33}$, and $\frac{2}{77}$. And simplify

$$\frac{2\frac{1}{4}}{2\frac{1}{3}}+\frac{2\frac{1}{2}+5\frac{1}{8}}{3\frac{1}{7}+9\frac{1}{2}}+\frac{1}{2}+\frac{3}{8}\text{ of }\frac{3}{20}.$$

3. Find the value of 17 cwt. 3 qr. 22 lb. at £4. 6*s*. $7\frac{1}{2}$*d*. per cwt.

4. Add together ·0125 of a pound, ·0625 of a shilling, and ·5 of a penny; and reduce 11*s* $9\frac{1}{4}$*d*. to the decimal of a pound.

5. Extract the square root of ·000196 and divide the result by 140.

6. A company guarantees to pay 5 per cent. on shares of ₨1,000 each; another guarantees to pay $4\frac{5}{8}$ per cent. on shares of ₨75 each; the price of the former is ₨1,245 and of the latter ₨85. Compare the rates of interest which the shares return to purchasers.

1865.

1. Find the value of $11\frac{3}{5}+14\frac{5}{8}+21\frac{7}{40}+32\frac{3}{320}$, both by vulgar fractions and by decimals, showing that the two results coincide; and reduce 25°. 36′. 45″ to the decimal of 75°.

2. Find the product of the sum and difference of ·0421 and ·0029, and divide one-tenth of the square root of that product by ten times the continued product of ·02, ·03 and ·07.

3. How many yards of matting 3·5 feet wide will cover the floor of a room 85·3 ft. long, and 40·5 ft. broad; and how much will it cost at ₨2. 10*a*. 8*p*. per *square* yard?

4. If the wages of 25 men amount to ₨766. 10*a*. 8*p*. in 16 days,

how many men must work 24 days to receive R1,035, the daily wages of the latter being one-half those of the former?

5. What principal in 3 years 73 days will amount to R100. 15*a*., at $6\frac{1}{4}$ per cent. simple interest? A bill for R5,035. 4*a*. drawn on September 12th at 5 months was discounted on January 16th at 4 per cent.; what was the discount charged?

1866, A.

1. Add together $\frac{5}{16}$, $\frac{7}{32}$, $\frac{3}{8}$, ·046875 and 1·23.

Simplify $\frac{\cdot0075+2\cdot1}{\cdot0175}$ and $\frac{4\cdot255+\cdot0064}{\cdot00032}$.

2. Find, by Practice, the value of 1 ton 5 cwt. 2 qr. 14 lb. at £3. 15*s*. 7*d*. per cwt.

3. Find the square root of 1524·9025 and of 152·49025 to three places of decimals; and the value of ·0099 of £1. 5*s*. 3*d*.

4. Three gardeners working all day can plant a field in 10 days, but one of them having other employment can only work half time. How long will it take them to complete the work?

5. Find the compound interest of £55 for one year, payable quarterly at 5 per cent. per annum.

1866, B.

1. Reduce 3°. 45′. 36″·25 to the decimal of 36°.

Simplify $\left(\frac{1}{3}+\frac{\frac{3}{7}}{1\frac{3}{5}}+1\frac{1}{4}+\frac{5}{9}-1\right)\div\frac{8}{9}$ of $\frac{5}{6}$ of $2\frac{5}{7}$

2. Find the value of 6 cwt. 2 qr. 7 lb. at £3. 4*s*. $6\frac{3}{4}$*d*. per cwt.

3. Find the square of 0·0204 and the square root of 81·757764; and divide one-tenth of the latter result by one hundred times the former.

4. Divide 0·1001 by 0·000390625, and 10·01 by 390·625.

5. What is the expense of paving a rectangular verandah whose length is 42 feet and breadth 15 feet with Burdwan paving stones, 18 inches square, and which cost R15 per score?

6. The 3 per cents. are at $85\frac{1}{8}$; what price should the $3\frac{1}{2}$ per cents. bear, that an investment may be made with equal advantage in either stock? And what interest would be derived by so investing 5000*l*.?

1867.

1. The driving wheel of a locomotive is 225 inches in circumference, and makes 98 revolutions per minute; at what rate per hour is the engine travelling?

2. Divide the least common multiple of 156, 260, 720 and 429 by their greatest common measure, and find the square root of the quotient.

3. If a butcher buy 10 cwt. of beef at 44*s*. 4*d*. per cwt. and sell it at the rate of $4\frac{1}{2}$*d*. per lb., how much does he lose or gain?

4. Find the value of the following expressions :—

$$\frac{5\frac{1}{4} \times \frac{2}{3}\frac{?}{} \times 9\frac{1}{2} \times 3\frac{1}{16}}{1\frac{6}{7} \times 67} \text{ and}$$

$$\frac{0\cdot625 \text{ of } £143.\ 12s.\ 0d. + 0\cdot025 \text{ of } £71.\ 16s.\ 0d.}{\frac{?}{?} \text{ of } 5175}.$$

5. Reduce £1. 5*s.* 6*d.* to the fraction of £1,000, and 5*s.* 1$\frac{3}{5}$*d.* to the fraction of £150. 10*s.*, and express the results both as vulgar and decimal fractions.

6. If £450 amount to £523. 10*s.* in 1 year 8 months, calculate the rate per cent.

1868.

1. Find the difference between 1·6 of 3·4 of £1·125 and [illegible] of $3\cdot\dot{6}$ of £9·1125, and find the value of—

$$\frac{6\cdot27 \times 0\cdot5}{(\frac{1}{2} \text{ of } [illegible]) \times 8\cdot36} \div \frac{(\frac{1}{4} \text{ of } \frac{1}{10}) \times ([illegible] \text{ of } 21\frac{1}{3})}{([illegible] \text{ of } \frac{3}{8}) + 1\cdot\dot{4}}.$$

2. Extract the square root of 153·140625, and of 3·3 each to three places of decimals.

3. If one man walks 165 miles in 6 days, how far will another man walk in 15 days if the first man walks 3$\frac{1}{4}$ miles in the same time that the other man walks 4 miles ?

4. Three equal glasses are filled with a mixture of spirits and water ; the proportion of spirits to water in each glass is as follows :—in the first glass as 2 : 3, in the second as 3 : 4, and in the third as 4 : 5. The contents of the three glasses are poured into a single vessel : what is the proportion of spirits to water in it ?

5. Find the interest on £350 from 3rd March to 28th December at 4$\frac{1}{2}$ per cent. per annum.

6. How many yards of carpet 25 inches wide will be required for a room 19 feet 7 inches long, and 18 feet 9 inches wide ?

1869.

1. Simplify $\dfrac{1+\frac{1}{2}+\frac{1}{3}+\frac{1}{4}-\frac{1}{12}}{\frac{1}{3}+\frac{1}{6}} \div \dfrac{\frac{1}{2}+\frac{1}{3}}{1-\frac{1}{2}\times\frac{1}{3}}$,

and reduce 4 hr. 1 min. 10$\frac{1}{2}$ sec. to the decimal of a week.

2. Add together ·062435 of 100*l.* + 7·4375 of 10*s.* + $1\cdot35\dot{6}$ of 7*s.* 6*d.* + 2·784 of 2$\frac{1}{2}$*d.*, and reduce the result to the fraction of 29*l.* 10*s.* 7$\frac{1}{2}$*d.*

3. Divide ·0007 by ·035 and by 3500, and extract the square root of each quotient to four decimal places.

4. A room is 37 ft. 2 in. long, 25 ft. 3 in. broad, and 22 ft. 6 in. high : find the cost of covering its four walls with paper 1$\frac{1}{4}$ yd. wide, at 1*s.* 1$\frac{3}{4}$*d.* a yard.

5. In what time will 563*l.* 13*s.* 4$\frac{1}{2}$*d.* amount to £901. 17*s.* 5$\frac{4}{5}$*d.* at 3$\frac{3}{4}$ per cent ?

1870.

1. Find the cost of matting a room whose floor is 8 yards long by $7\frac{1}{4}$ yards wide, with mats 2 ft. wide and $9\frac{1}{2}$ ft. long, at the rate of 9 annas 2 pies per mat.

If the same room be $15\frac{1}{3}$ ft. high, find how many cubic feet it will contain.

2. Distinguish between a vulgar fraction and a decimal fraction.

Multiply $999\frac{998}{999}$ by 999.

State the rule for the multiplication of decimals, and apply it to point the products in (i) $1{\cdot}23 \times {\cdot}0011$ and (ii) $29000 \times {\cdot}01$.

Divide ${\cdot}\dot{3}\dot{7}$ by ${\cdot}\dot{1}4\dot{8}$, and show that $\dfrac{{\cdot}\dot{1}2\dot{3}}{{\cdot}\dot{4}\dot{1}} = \dfrac{123123}{414141}$.

3. Find the square root of $19740\frac{1}{4}$ and of $4\frac{1}{9}$, the latter to four places of decimals.

4. Two gangs of six men and nine men are set to reap two fields of 35 and 45 acres respectively. The first gang complete their work in 12 days, in how many days will the second gang complete theirs?

5. Find which is the better investment, $3\frac{1}{2}$ per cent. stock at $98\frac{1}{4}$, or $3\frac{3}{4}$ per cents. at 105

6. Find how many rupees are equivalent to 200*l.* at the rate of 1*s.* $11\frac{3}{16}$*d.* per rupee.

1871.

1. 6625 railway tickets were sold at a station, $\frac{3}{5}$ths of which were 9 annas each and the rest 5 annas each. What was the amount received for the tickets?

2. Find the greatest and least of the fractions $\frac{1}{7}$, $\frac{5}{24}$, $\frac{8}{49}$, $\frac{23}{108}$. Add together $2\frac{2}{5}$ of £2. 13*s.* $6\frac{1}{4}$*d.* and (£3. 15*s.* $9\frac{1}{2}$*d.*) $\div 6\frac{2}{7}$ and simplify:—

$$\frac{2\frac{1}{3} - 1\frac{3}{4}}{4 \text{ of } 1\frac{1}{8} + 6 \times \frac{1}{2}} \times \frac{5 - \frac{5}{6}}{\frac{1}{3} + \frac{2}{5}} + \frac{5}{8}.$$

3. Divide ${\cdot}027$ by $14{\cdot}4$ and $1208{\cdot}04$ by ${\cdot}01\dot{7}$. Find the value of $11{\cdot}1375$ of R6. 8*a.* – ${\cdot}56$ of R7. 8*a.* and reduce 8*a.* 6*p.* to the decimal of R3. 7*a.*

4. If the carriage of $9\frac{3}{4}$ md. for a distance of 80 miles be R3, how many miles should 130 md. be carried for R27. 8*a.*?

5. What sum of money will amount to R3761. 14*a.* in $3\frac{1}{2}$ years at $4\frac{5}{8}$ per cent. per annum simple interest?

1872.

1. A merchant bought goods which cost him R9,810. In the first day he sold to the amount of R992. 8*a.* 6*p.*, in the second to that of R1,992. 8*a.* 3*p.*, and in the next three days to an amount equal to twice the two former. Finding that he had one-fourth of the goods left he calculated his profits in the five days. How much were they?

2. What fraction of R10 is R6. 10*a*. 8*p*. ?

Find the value of $\frac{5}{6}$ of R2. 8*a*. + $\frac{3}{5}$ of R4. 11*a*. + 2·05 of R5.

Simplify $4\frac{1}{3}$ of $\frac{3}{50} - \frac{\frac{3}{7}}{2\frac{4}{9}} + \frac{5\frac{1}{5} - 4 \text{ of } \frac{3}{5}}{3\frac{1}{4} - 3\frac{1}{2}}$.

3. Divide 274·72 by ·0544 ; find the value (correct to six places of decimals) of (i) $\frac{\cdot 00\dot{3} \times \cdot 05}{\cdot 0022}$, (ii) $6\cdot\dot{0}4\dot{5} - 5\cdot 3\dot{6}7\dot{8}$; and extract the square root of 951·1056.

4. Find, by Practice, the cost of 15 md. 15 sr. 11 ch. of oil at R12. 10*a*. 3*p*. per maund.

5. If the interest of R1,000 in 5 years be R250. what will be the interest of R3,500 for 1 year and 6 months ?

1873.

1. Find the value of (i) $\frac{1 + 2\frac{1}{2} + 3\frac{1}{3}}{\frac{1}{1\frac{1}{2}} + \frac{2}{2\frac{1}{3}} + \frac{3}{3\frac{1}{4}}}$, $\frac{55\frac{3}{4} \div 11}{1\frac{2}{11} \text{ of } 13\frac{3}{5}}$,

(ii) $24\frac{2}{7}$ of R103. 7*a*. 6*p*.

If $\frac{6}{16}$ of a maund is worth R45, what is the price of $\frac{1}{8}$ of a maund ?

2. Reduce $\frac{1}{64}$ to a decimal ; $\cdot 01\dot{9}$ to a vulgar fraction ; and

$$\frac{4\cdot\dot{2} - 3\cdot 1\dot{4}}{1\cdot 3 + 2\cdot 10\dot{2}} \text{ of } \frac{1\cdot 3 \text{ of } 4}{\cdot 37 \text{ of } 8\cdot\dot{8}\dot{1}}$$ to its lowest terms.

3. What is the expense of matting a room 31 ft. 5 in. long by 20 ft. 4 in. wide, the mat costing 14*a*. per 12 square *hath* (linear hath = 18 in.) ?

4. In what time will R8,500 amount to R15,767 8*a*. at $4\frac{1}{2}$ per cent. per annum ?

5. A person owes the sum of R31,500 and R8,500 ; and his property only amounts to R14,125. How much is he able to pay in the rupee ; and what is the loss upon the second debt ?

1874.

1. What fraction of $\frac{2}{7}$ of a rupee is $\frac{3}{5}$ of R5 ; and what proportion does their difference bear to their sum ?

Divide 999·666 by ·30036 ; and $2\cdot\dot{3}57142\dot{8}$ by $10\cdot\dot{2}14285\dot{7}$.

2. When rice is 10 seers the rupee, nine persons can be fed for 30 days at a certain cost. For how many days can six persons be fed at the same cost when rice is 14 seers the rupee ?

3. A wooden box 3 ft. 8 in. long, 2 ft. 3 in. high, and 2 ft. 4 in. wide, is made of board one inch thick. Find the quantity of wood used, and the cubical content of the box.

4. It is said that 240,000 letters are posted in Berlin daily. 16·6 per

cent. of which are town letters. This gives one letter for every three persons in Berlin ; what is its population ?

5. What sum will amount to a *lakh* of rupees in ten years at 5 per cent. simple interest ?

Find the discount on R1,308 due two years hence at $4\frac{1}{2}$ per cent. per annum.

1875.

1. Simplify $\dfrac{17}{7+\dfrac{3}{4-2\frac{3}{4}}} \times \dfrac{2021}{2193} \div \left(1\dfrac{37}{48} - \dfrac{15}{16}\right)$.

Find the value of $\frac{4}{15}$ of R17. 6a. 2p. + $3\frac{2}{3}$ of R12. 5a. $11\frac{1}{3}$p. + R5·4958$\dot{3}$; and extract the square root of ·049 to four places of decimals.

2. A person received on the death of his aunt $\frac{1}{16}$ of her property and spent ·$\dot{5}\dot{4}$ of it in paying off his debts ; what fraction of his aunt's property did he then possess ?

3. A room is 30 ft. long, 22 ft. wide, $18\frac{1}{2}$ ft. high, and has 5 doors and 3 windows ; find the expense of colouring the walls at 3*a*. per sq. yd., deducting 30 sq. ft. for each door and window.

4. Find the *present worth* of R19,021 due 4 years hence at $3\frac{1}{4}$ per cent.

5. If R16,430 be invested in the Government $4\frac{1}{2}$ per cent. loan at 106, what is the monthly income derived ? Supposing that the loan is paid off at par in 10 years, what would be the rate of simple interest (per cent. per annum) on the sum invested ?

1876.

1. Simplify $\dfrac{5\frac{4}{7}-3\frac{8}{9}+4\frac{1}{21}}{3\frac{1}{3}+\dfrac{1+\frac{1}{8}}{2-\frac{5}{8}}}$.

Find the value of $\frac{5}{21}$ of R16. 14*a*. − 1·1$\dot{4}$ of R5. 0*a*. 3*p*. + $1\frac{5}{8}$ of R9 6*a*. 6*p*.

Reduce (16·0$\dot{5}$ − 6·2$\dot{5}$) of a rupee to the decimal of R22. 1*a*.

2. An equal number of men, women, and boys earned R39. 6*a*. in 7 days. Each boy received 2*a*. a day, each woman 3*a*. 6*p*., and each man 4*a*. 6*p*. How many were there of each ?

Find the square root of 531·065 to five places of decimals.

3. How many yards of matting 2 ft. 4 in. wide will be required for a square room, whose side is 9 ft. 4 in. ? and what will be the price of it at 2*a*. 3*p*. per yard ?

Find the value of 33 cwt. 3 qr. 7 lb. at £6. 7*s*. 8*d*. per cwt.

4. If 4,000 men have provisions for 190 days, and if after 30 days 800 men go away, find how long the remaining provisions will serve the number left.

5. At what rate per cent., simple interest, will R1462. 8*a*. amount to R1725. 12*a*. in 4 years ?

1877.

1. Simplify $\dfrac{\frac{1}{4}+\frac{2}{9}}{4-\frac{5}{6}\text{ of }5\frac{1}{2}} \div \dfrac{\frac{2}{5}+\frac{1}{4}}{\frac{7}{10}\text{ of }4\frac{1}{2}-2\frac{1}{2}}$, and find the value of $\frac{4}{26}$ of 10*s*. 11*d*. + $\frac{3}{32}$ of £1. 1*s*. 4*d*. + £3·2$\dot{3}$.

2. Find, by Practice, the value of $739\frac{1}{2}$ maunds of sugar at R123. 4*a*. per hundred maunds.

3. Find the discount on £453. 15*s*. due 6 years hence at $3\frac{1}{2}$ per cent. per annum.

4. A man sells 3 per cent. stock at 75, and invests the proceeds in 5 per cents. ; at what rate must he buy them in order that his income may be the same as before ?

5. If 7 men and 5 boys can reap 168 acres in 18 days, how many days will 15 men and 5 boys take to reap 700 acres, one man being able to do three times as much work as a boy ?

6. In a rectangular area, 100 yards long and 50 yards broad, there are two paths crossing one another, each parallel to one side of the rectangle, and each 4 yards broad. Find the cost of paving the area with stone at 12*a*. per square yard, and of covering the paths with gravel at 6*a*. per square yard.

1878.

1. Calculate to three places of decimals the value of $\dfrac{180 \times 36}{3{\cdot}14159}$.

2. Calculate to five places of decimals the square root of $1 + ({\cdot}067)^2$.

3. Reduce R483. 12*a*. 6*p*. to the decimal of R1,290. 1*a*. 4*p*.

4. Find the simple interest on R757. 4*a*. 3*p*. for 343 days at $3\frac{1}{2}$ per cent. per annum.

5. Add together $\frac{1}{125}$, [illegible], [illegible], [illegible]. Express your answer as a decimal.

6 Find, by Practice, the value of 99 cwt. 3 qr. 27 lb. at £5. 2*s*. 6*d*. per cwt.

1879.

1. What is the local value of each of the figures composing the number 456·654.

2. R49 was divided amongst 150 children, each girl had 8*a*. and each boy 4*a*. ; how many boys were there ?

3. Simplify—

$$(a)\ 8 - 8 \times \frac{2\frac{1}{3} - 1\frac{2}{3}}{2 - \dfrac{1}{6 - \frac{1}{3}}}.$$

(b) $\frac{1}{6}+\frac{1}{8}\div\frac{1}{7}-\frac{1}{7}\times\frac{1}{8}-\frac{1}{6}$.

(c) $\cdot 15\dot{9}\dot{0}\times\cdot 47\dot{2}\div 2\cdot\dot{7}$.

(d) What decimal of £4. 3*s*. 4*d*. is $\frac{1}{1300}$ of £5. 8*s*. 4*d*. ?

4. A tank 75 yards long, 50 yards broad, and 11 feet deep, is full of water; how many times can each of 16 water-carts, length 5 ft., breadth 5 ft., and depth 27 inches, be filled from the tank before the water in it falls 6 inches?

5. If 17 men can build a wall 100 yards long, 12 ft. high and 2½ ft. thick in 25 days, how many will build a wall twice the size in half the time?

6. Find the change of income when a person transfers £2,616. 5*s*. from the 5 per cents. at 95⅜ to the 4 per cents. at 83, brokerage as usual.

7. In a game of skill *A* can give *B*, and *B* can give *C*, 10 points out of a game of 50; how many should *A* give *C*?

1880.

1. Express each of the figures composing the number 123·456 as a multiple or sub-multiple of 10.

What fraction must be added to $2\frac{1}{3}+\dfrac{3\frac{1}{3}-\frac{1}{6}}{3\frac{1}{3}+\frac{1}{6}}-2\frac{2}{7}$ of $\frac{4}{10}$ that the sum may be equal to 3?

2. (a) What fraction of ⅔ of R187. 5*a*. is R28. 8*a*. ?

(b) Of what sum of money will ·325 be £13?

(c) Extract the square root of 7·0225.

3. Divide £127. 8*s*. among 2 men, 3 women and 7 boys, giving each of the boys ½ of what a woman receives and each of the men twice as much as a woman.

4. A leaky cistern is filled in 5 hours with 30 pails of 3 gallons each, but in 3 hours with 20 pails of 4 gallons each, the pails being poured in at intervals. Find how much the cistern holds, and in what time the water would waste away.

5. A race-course is ½ a mile long; *A* and *B* run a race and *A* wins by 10 yards; *C* and *D* run over the same course and *C* wins by 30 yards; *B* and *D* run over it and *B* wins by 20 yards; if *A* and *C* run over it which should win, and by how much?

6. A tradesman puts two prices on his goods: one for ready money, the other for 6 month's credit, interest being calculated at 12½ per cent. per annum. If the credit price of an article be R26. 9*a*., what is its cash price?

1881.

1. What do you mean by *Multiplication*? Define *quotient*, *factor*, *power*, *expression* and *dimension*.

2. Add together $\frac{1}{2}$, $\frac{2}{3}$, $\frac{3}{4}$, $\frac{4}{5}$, $\frac{5}{6}$, and $\frac{6}{7}$: and simplify

$$\frac{\frac{3}{7}-\frac{2}{9}}{\frac{3}{7}+\frac{2}{9}} \text{ of } 2\frac{1}{4} \div \frac{4}{13-3\frac{8}{9}} + 3\frac{1}{18} - \frac{7}{3-1\frac{10}{13}}.$$

3. What decimal of R45 is R35. *2a.* *6p.*? Find the value of

$$\frac{1{\cdot}07\dot{4}}{{\cdot}0015} \text{ of } 8\tfrac{1}{2} \text{ annas.}$$

4. Express $37{\cdot}84\dot{6}\dot{3}$ as an improper vulgar fraction in its lowest terms; and find, correct to 4 places of decimals, the result of dividing the square root of this number by the square root of 11.

5. A man who has a certain capital calculates that if he invest it in $3\frac{1}{4}$ per cent. stock at 91 his income will be £25 more than if he invest it in 3 per cent. stock at 88. What is his capital?

1882.

1. The quotient arising from the division of 6739546 by a certain number is 1559 and the remainder is 3107: find the divisor.

2. Subtract $\frac{2}{3}$ of $\frac{3}{8}$ of $\frac{4}{25}$ of £31. 5*s*. from $\frac{4}{7}$ of $\frac{8}{17}$ of $\frac{12}{14}$ of £100. 16*s*. 8*d*., and express the remainder as the decimal of £10. 8*s*. 4*d*.

3. Seven bells begin to strike simultaneously and strike at intervals of 2, 3, 5, 15, 21, 65, 77 seconds respectively. After what time will they again strike simultaneously, and how often will each have struck?

4. (i) Simplify $\frac{2\frac{2}{3}+5\frac{7}{8}}{1\frac{1}{2}-\frac{1}{6}} \div \left(\frac{2}{25} \text{ of } \frac{7}{12} \text{ of } \frac{31}{36}\right)$.

(ii) Find the value of $\frac{\sqrt{(15)}+\sqrt{(13)}}{\sqrt{(15)}-\sqrt{(13)}}$ to five places of decimals.

5. A besieged garrison consists of 300 men, 120 women, and 40 children, and has provisions enough for 200 men for 30 days. If a woman eats $\frac{7}{8}$ as much as a man, and a child $\frac{1}{2}$ as much, and if after 6 days 100 men with all the women and children eacape, for how long will the remaining provisions last the garrison?

6. A person begins to speculate with a certain sum of money: in his first transaction he loses $\frac{1}{4}$th of this sum: in his second he gains 10 per cent. on his investment: in his third he loses $\frac{5}{11}$ths of the sum invested: in his fourth he gains $66\frac{2}{3}$ per cent. If he then has R10,000, with what sum did he start?

1883.

1. Divide $2\frac{1}{3}+8\frac{6}{11}-\frac{1}{3}$ of $(7\frac{1}{2}-3\frac{1}{8})$ by $11+\cfrac{1}{1-\cfrac{1}{1+\cfrac{1}{8\frac{1}{11}}}}$.

2. Divide the square root of $122{\cdot}2572\dot{4}\dot{9}$ by ${\cdot}368\dot{5}\dot{6}$ and multiply the quotient by the square root of ${\cdot}000625$.

3. What decimal of a square yard is 9 square inches? Add together 1·032 of R5., ·64 of R1·25 and ·08 of half a rupee. What is the value of £10·5416?

4. Find by "Practice" the value of 6 tons 3 cwt. 21 lb. 14 oz. at £3. 10s. per ton.

5. If it costs R200 to build a wall 6 ft. high by 1 ft. 3 in. broad by 165 ft. 8 in. long, what will be the cost of building a wall $3\frac{1}{2}$ ft. by $1\frac{1}{3}$ ft. by 115 ft.?

6. When will the interest amount to the principal at $3\frac{1}{2}$ per cent. per annum? What will the interest on R150 at one anna per rupee per month amount to in 5 years, and how much is that rate per cent. per annum?

1885.

1. Of what number is $2\frac{1}{6}$ the $\frac{5}{6}$th part?

By what fraction must $\frac{1\frac{1}{4}}{1\frac{1}{12}}$ of $\frac{3}{8}+\frac{2\frac{1}{3}-1\frac{7}{8}}{\frac{1}{4}+1\frac{3}{8}}-\frac{8\frac{1}{4}}{7\frac{1}{4}}$ be divided in order to give a quotient $=\frac{7}{3}$?

2. Simplify $\frac{\cdot 12 \text{ of } (\cdot 0104-\cdot 002)+\cdot 36\times\cdot 002}{\cdot 12\times\cdot 12}$;

and express your result as a fraction of ·6. Reduce $\frac{5}{8}$ of 16s. $4\frac{1}{2}d.$ to the decimal of £1. 9s. $10\frac{1}{4}d.$

3. What circulating decimal multiplied by $\frac{2\frac{3}{7}}{4\frac{1}{2}}$ will give 2 for a product?

If $\cdot\dot{4}2857\dot{1}$ of a barrel of beer be worth ·72 of £2. 10s., what is the value of ·625 of the remainder?

4. Find the price of 10 lb. 11 oz. 16 dwt. 16 gr. of gold at £3. 17s. $10\frac{1}{2}d.$ per oz.

Extract the square roots of $9\frac{5}{8}$ and $\frac{1}{12\cdot 5}$ to 4 places.

5. If 27 men can perform a piece of work in 15 days, how many men must be added to the number that the work may be finished in three-fifths of the time?

I buy a horse for £40 and sell it for £45 at a credit of 8 months. What do I gain per cent., reckoning money worth 6 per cent. per annum?

6. Which is the better investment, bank stock paying 10 per cent. at 319 or 3 per cent. consols at 96?

What will be the cost of £1,500 3 per cent. consols at $89\frac{3}{8}$, brokerage being $\frac{1}{8}$ per cent.? What rate of interest will such investment obtain?

1886.

1. Divide $\frac{1\frac{3}{5}\div 1\frac{2}{5}}{1\frac{1}{3}\div 1\frac{1}{4}}+\frac{1\frac{3}{7}+1\frac{2}{7}}{1\frac{1}{3}\div 1\frac{1}{16}}$ by $\frac{\frac{1}{2}\div\frac{1}{3}}{\frac{1}{11}\div\frac{1}{13}}+\frac{\frac{1}{17}\div\frac{1}{18}}{\frac{1}{19}\div\frac{1}{20}}$.

2. Simplify $\frac{3\cdot125}{2\cdot16}$ of $\frac{\cdot2\dot{4}}{\cdot125} \div \frac{2\cdot\dot{2}}{1\cdot5}$ of $\frac{187\cdot5}{3\cdot42}$.

3. Reduce £1. 11*s.* 10½*d.* to the fraction of £7. 18*s.* 6¾*d.* What fraction of £10 must be added to £16. 10*s.* 3*d.* to make it £20?

4. What decimal of 9 mds. 20 seers is $\frac{3}{5}$ of 7 mds. 5 seers? Reduce 5½ sq. yd. to the decimal of an acre.

5. Find the value, by Practice, of 2 tons 15 cwt. 35 lb. at £13. 6*s.* 8*d.* per ton.

6. What sum of money at 4 per cent. simple interest will secure the same income as R25475 at 4½ per cent.?

7. If a rupee is equivalent to 1*s.* 6¾*d.*, what is the price of a sovereign in rupees? If, after buying 250 sovereigns at this price, I sell them again when the rupee is equivalent to 1*s.* 6*d.*, how much shall I gain or lose by the transaction?

1887.

1. Simplify :—

(*a*) $(4\frac{3}{8} - 1\frac{1}{8}) \times (3\frac{1}{2} - \frac{5}{8}) \div (13\frac{1}{8} + 7\frac{1}{3})$ of $\frac{3\frac{1}{8}}{1\frac{1}{9}}$.

(*b*) $\frac{1\cdot8\dot{3} + 2\cdot041\dot{6} + \cdot\dot{3} - 3\frac{1}{8}}{1\cdot0025 + \cdot0025 - 1\frac{1}{18}}$.

2. Express $\frac{5}{9}$ of 7*s.* 6*d.* + 1·25 of 5*s.* − ·5$\dot{4}\dot{5}$ of 9*s.* 2*d.* as a decimal fraction of £10.

3. (*a*) Find, by Practice, the value of 5 tons 5 cwt. 2 qr. 17½ lb. at £3. 6*s.* 8*d.* per ton.

(*b*) Find the income on which the income-tax at 5*p.* per rupee is R52. 1*a.* 4*p.*

4. If 50 men can do a piece of work in 12 days, working 8 hours a day, how many hours a day would 60 men have to work in order to do another piece of work twice as great in 16 days?

5. If R450 amount to R540 in 4 years at simple interest, what sum will amount to R637. 8*a.* in 5 years at the same rate?

6. Extract the square root of 177·1561, and of ·$\dot{2}$ to 3 decimal places.

1888.

1. Simplify $\frac{\frac{7}{9}(\frac{4}{15} \text{ of } 3\frac{1}{8} - \frac{1}{8} \text{ of } 2\frac{1}{4})}{\frac{11}{38} \times 1\frac{6}{17} \times 1\frac{16}{19} - \frac{7}{30} \div 2\frac{1}{8}} \div \frac{\frac{1}{8} + \frac{5}{17} - \frac{1}{13}}{\frac{1}{8} \times \frac{1}{4} - \frac{1}{17} \times 1\frac{4}{13}}$.

2. Divide 16·016 by ·00143, and extract the square root of 1440·9616.

3. Add together 55·500$\dot{2}$, 3·$\dot{1}\dot{7}$, 4·$\dot{5}0\dot{6}$, and 75·$\dot{2}7\dot{1}$, and find the value of the following :—·7365 of £3. 6*s.* 8*d.* + ·504 of £15. 12*s.* 6*d.* + 2·102083 of £5.

4. Find by "Practice" the value of 2 tons 7 cwt. 3 qr. 11 lb. at £21. 12*s.* 6*d.* per cwt.

5. A man can walk 600 miles in 35 days, resting 9 hours each day; how long will he take to walk 375 miles if he rests 10 hours each day, and walks $1\frac{1}{2}$ times as fast as before?

6. If the interest on money be one pie per rupee per month, what is the rate per cent. per annum?

A man holds $15\frac{1}{4}$ shares of a bank, and receives £19. 1*s.* 3*d.* per quarter. If the interest he receives be 5 per cent. per annum, find the value of a share.

1889.

1. Multiply ·0069347 by 7439·6.

2. Divide 2100·006983 by 243·5846 correct to five places of decimals.

3. Find in any way the value of 1,347 cwt. 3 qr. and 21 lb. at £3. 17*s.* $10\frac{1}{4}$*d.* per cwt.

4. Extract the square root of $1+(\cdot0634)^2$ to six places of decimals.

5. Find in English money the value of R100,000 at 1*s.* $4\frac{8}{25}$*d.* per rupee.

1890.

1. Simplify $2\frac{3}{7}$ of $\dfrac{13\frac{1}{2}-9\frac{2}{3}}{15\frac{1}{3}-11\frac{7}{16}} \div 3\frac{2}{7}+\dfrac{1\frac{1}{6}}{9\frac{2}{6}-8\frac{4}{9}}$, and find by Practice the value of 3,049 articles at R7. 13*a.* 7*p.* each.

2. Divide 27·03 by ·0037, and reduce $\cdot7\dot{5}-\cdot1\dot{0}\dot{2}-\cdot2\dot{7}$ to a vulgar fraction.

3. Find the cost of putting a fence round a square field whose area is 13·225 acres at R1. 12*a.* per yard.

4. A piece of work can be done in 72 days by 17 men working together. If after 9 days of work these are joined by 4 others, in how many days will the work be finished?

5. Find the price of $4\frac{1}{2}$ per cent. Government Promissory Notes when an investment of R59,422. 8*a.* produces a monthly income of R213. 12*a.*

1891.

1. Simplify the following expressions:

(*a*) $\dfrac{\frac{3}{5}-\frac{2}{7}}{\frac{5}{6}-\frac{4}{5}} \div \dfrac{\frac{4}{7}-1\frac{3}{10}}{\frac{1}{6}-\frac{1}{11}}$ (*b*) $\dfrac{\cdot1}{4-\dfrac{1}{2-\dfrac{1}{1-\frac{5}{13}}}}$.

2. Find the value of $2\cdot4607\times\cdot06-3\cdot75\times\cdot012+2\cdot1\dot{6}3\div1\cdot03$.

3. Find the value of 15 cwt. 3 qr. 9 lb. at R25. 12*a.* 7*p.* per cwt.

4. If a man walking at the rate of $3\frac{1}{2}$ miles an hour, walks to a place in 4 hours 30 minutes, how long will it take a man, walking at the rate of $3\frac{1}{4}$ miles an hour, to walk there and back?

5. A man invests a certain sum in $4\frac{1}{2}$ per cent. Government Paper at 104. The price falling to 101, he sells out and loses R600 by the transaction, exclusive of brokerage. Find the sum invested.

6. *A* gives *B* 10 yards' start and *C* 15 yards' start in a race of 100 yards; how much should *B* give *C* in 150 yards?

1892.

1. Simplify $\dfrac{3\frac{5}{6} - 1\frac{7}{8} \text{ of } 2\frac{4}{7}}{11\frac{2}{3} \text{ of } \frac{9}{14} \text{ of } \frac{3}{5}} - \dfrac{4\frac{1}{8} - 7\frac{5}{6} + 3\frac{2}{3}}{\frac{5}{6} \text{ of } 12}$.

2. Find, to the nearest integer, the value of $\dfrac{39{\cdot}37 \times 760 \times 13{\cdot}596}{1{\cdot}293 \times 12}$.

3. Find the square roots of ·097344, of ·009604, and of ·996004.

4. Find the interest on 10 lakhs of rupees for 10 days at $4\frac{1}{2}$ per cent. per annum.

5. £3,000, which I held in the Four per cents., was sold for me when they were at $82\frac{3}{4}$ by a broker whose commission is $\frac{1}{4}$ per cent.: and the proceeds were re-invested by him in the Four and a half per cents. at $98\frac{1}{4}$. What amount of the latter stock did he purchase?

1893.

1. Simplify :—

(1) $1 + \frac{1}{2} + \frac{2}{3} + \frac{3}{4} + \frac{4}{5} + \frac{5}{6} + \frac{6}{7}$:

(2) $\dfrac{8\frac{1}{7} - 1\frac{1}{6}}{\frac{3}{5} + 1\frac{1}{2}} - \dfrac{1}{5\frac{3}{4} - 1\frac{1}{6}}$.

2. Divide 1·84626 by 23·4.

Express $\cdot4\dot{5}\dot{6}$ and $\cdot6\dot{5}\dot{4}$ as vulgar frations reduced to their lowest terms, and their sum as a circulating decimal.

3. Find the cost of 73 cwt. 3 qr. 14 lb. at £4. 13*s.* 6*d.* per cwt.

4. Distinguish between true discount and banker's discount.

Find the former in the case of a bill for R3486. 6*a.* 8*p.* due 16 months hence, the rate of interest being $5\frac{1}{4}$ per cent. per annum.

5. A man invests R163000, part in Government 4 per cent. stock at 108, and the remainder in Municipal 5 per cent. debenture stock at $109\frac{1}{2}$. Find how much he must invest in each in order that he may have an equal ncome from the two sources.

1894.

1. In a compound metal containing tin and copper only, the proportion of tin to copper is 7·75 to 92·25. Find to the nearest penny the value of 8 cwt. 3 qr. of it. Tin cost [illegible]*l.*; copper 80*l.* per ton.

2. A rectangular court is 50 yards long and 30 yards broad. It has paths joining the middle points of the opposite sides of 6 feet in breadth and also paths of the same breadth running all round it. The remainder is

covered with grass If the cost of the pavement be 1s. 8d. per square foot and the turf 3s. per square yard, find the cost of laying out the court.

3. Find the value of $\cdot 267\dot{1}87\dot{5}$ of £3 in shillings, pence, and decimal of a penny.

4. Find the square root of $1-(\cdot 0578)^2$ to four places of decimals.

5. At a cricket match, a contractor provided luncheon for 24, and fixed the price to gain $12\frac{1}{2}$ per cent. on his outlay. Three persons were absent. The remaining 21 paid the fixed price, and the contractor lost 2 rupees. What was the charge ?

1895.

1. Find the square root of $1+\frac{1}{2}(\cdot 0345)^2$ correctly to four places of decimals.

2 Find the sum of money which put out at simple interest at $2\frac{3}{4}$ per cent. per annum will in 134 days exactly produce R124 10a. $1\frac{13}{73}p$.

[A year contains 365 days.]

3. If one pound sterling be worth twenty-five francs and sixty centimes ; and also worth six thalers and twenty silber groschen ; how many francs and centimes is one thaler worth ?

[N. B. one thaler = 30 silber groschen.
one franc = 100 centimes.]

4. Simplify

$$\frac{1\frac{3}{4}-\frac{5}{12}}{1\frac{1}{4}+\frac{5}{12}}+\frac{5}{8} \text{ of } \frac{9\times 5}{14\times 3}-\frac{11}{15}.$$

5. I invest R12805 in the four per cents. at $98\frac{1}{4}$, and when they have risen to $102\frac{3}{8}$ I sell out and invest in the $4\frac{1}{2}$ per cents at $105\frac{3}{8}$: what is the change in my income ? (Brokerage $\frac{1}{8}$ per cent. on all transactions).

Or convert $\frac{14}{15}$ into a decimal fraction, pointing out accurately the recurring portion (if any).

1896.

1. What greatest number and what least number can be subtracted from 23759143 that the remainders may be divisible by 24, 35, 91, 130, and 150 ?

2. (1) Simplify

$$\frac{54}{6\frac{3}{7}} \text{ of } \frac{6\frac{7}{11}}{9\frac{1}{3}} \div \frac{3}{8}\left(2\frac{3}{11}+\frac{13}{14}\right) \text{ of } \frac{7s.\ 6d.}{12s.\ 6d.}$$

(2) Divide $\cdot 0023465$ by $\cdot 03125$.

3. Extract the square root of $5\frac{1}{7}$ correct to 4 places of decimals.

4. Find the simple interest on R4235. 12a. $9\frac{1}{2}p$. for 3 years and 7 months at $3\frac{1}{2}$ per cent. per annum.

5. If by selling a horse for R1100, I lose 18 per cent. ; how much per cent. should I have gained or lost, had it been sold for R1320 ?

6. A man invested the same sum in two different stocks, $3\frac{1}{2}$ per cent. Government Securities at $103\frac{1}{2}$ and 4 per cent. Municipal Debentures at 105; his income from one is R93 more than from the other: what sum was invested in each stock?

1897.

1. Reduce

$$\frac{2\frac{1}{3}-1\frac{1}{4}}{2\frac{1}{3}+1\frac{1}{4}}\times 15\frac{17}{30}\div\frac{3\frac{1}{3}\times 3\frac{1}{3}\times 3\frac{1}{3}-1}{3\frac{1}{3}\times 3\frac{1}{3}+3\frac{1}{3}+1}$$

of 1 cwt. 3 qr. 7 lb. to the decimal of $2\frac{1}{2}$ tons.

(*a*) Find the vulgar fraction equivalent to the recurring decimal $\cdot 1\dot{3}\dot{3}$, without assuming any rule.

2. What do you understand by an *aliquot* part of a quantity? Is an area equal to $15\frac{1}{8}$ sq. yd. an aliquot part of an acre?

Find, by Practice, the income-tax on R1250. 10*a*. 8*p*. at the rate of 5 pies per R.

3. What is meant by the *ratio* of one quantity to another? What is a *proportion*?

320 people dine together 4 days a week, but on the remaining 3 days some are absent; the consumption of food is thus reduced, for the whole week, in the ratio of 109 to [illegible]. Find the number of absentees.

4. In what time will R3546 amount to R7683 at $3\frac{1}{2}$ per cent. simple interest?

5. A person has stock in the $3\frac{1}{2}$ per cent. Government securities, which yields R2856 a year. He sells out half of the stock at $109\frac{3}{4}$, and invests the proceeds in Howrah mills shares at 153. What dividend ought the latter to pay that he may thereby increase his annual income by R330?

6. Extract the square root of 3·14159 to 4 decimal places.

II. UNIVERSITY OF MADRAS. ENTRANCE PAPERS.

1857.

1. Simplify the expression $(\frac{3}{5}-\frac{1}{4})\times(\frac{5}{6}+\frac{2}{7})\times 2\frac{8}{21}+\frac{1}{6}$.

2. Divide ·000247 by ·013.

3. What is the equivalent in Indian coin, of 39*l.* 5*s.* $9\frac{3}{4}$*d.* when a rupee is worth 2*s.* $0\frac{3}{4}$*d.*?

4. Extract the square root 187·9541.

5. A tank is 300 yards long and 150 yards broad; with what velocity per second must water flow into it through an aperture 2 feet broad and $1\frac{1}{2}$ feet deep, that the level may be raised $\frac{1}{2}$ foot in 9 hours?

6. Find the interest of £250 for $3\frac{1}{2}$ years at $4\frac{1}{2}$ per cent. simple interest.

1858.

1. A company of 87 men have subscribed each a month's pay amounting to R13. 11*a*. 7*p*. for the benefit of the widows of their deceased comrades. There are 24 applicants; what is each widow's share?

2. A cubical tank, 24 feet long, 18 ft. 6 in. wide and 12 ft. 4 in. deep, is filled with water. Find the weight of water supposing that a cubic foot weighs 1000 oz. How long will it take to discharge itself at the rate of 15 gallons a minute assuming that a pint of water weighs 1 lb.?

3. A rectangular field is $\frac{3}{16}$ths of a mile long and $\frac{4}{16}$ths of a mile wide, find the length of a line joining two opposite angles.

4. Find the number of degrees, minutes and seconds in an arc of a circle which is equal in length to its radius, the ratio of the diameter to the circumference being 1 : 3·14159.

5. What must I pay for a bill of exchange on London for £73. 15*s*. 6*d*., the exchange being at the rate of 1*s*. 10$\frac{3}{4}$*d*. for the rupee?

6. A person having R8,500 in 4 per cent. Government bonds sells out when they are at 8$\frac{1}{4}$ per cent. discount, and with the amount thus realised purchases 5 per cent. bonds, which are at 6$\frac{3}{8}$ per cent. premium: what does he gain or lose in annual income by the change?

1859.

1. In Long Multiplication the general product is the sum of the several partial products. Illustrate this in the example, 2359 × 576, and write down, separately the several partial products with their factors.

2. The receipts on the Madras Railway for a certain week in January 1859, when there were 96 miles open, were R9,554. 3*a*. 10*p*.; for the corresponding week in 1858, when there were 81 miles open, they were R8,554. 6*a*. Compare the average receipts *per mile* for the two years.

3. State the Rule for division of Vulgar Fractions, and prove it, taking an example.

4. First multiply, and then divide ·2 by ·03, and verify your results. Finally find the sum of their square roots to three places of decimals.

5. A piece of land measures 10 cawnies 11 grounds 1075 square feet; find how many acres, roods and perches it contains, the cawny being 1·3223 acres.

6. The French unit of linear measure is a *metre*, equal to 39·371 English inches; the square formed on a line of 10 metres (called an *are*) is the French unit of surface. Find the equivalent in English square measure, of a hectare (100 ares).

7. The number of pupils in a school is 287, composed as follows: Hindoos 195, Mahommedans 63, Christians 28. The average daily number of absentees is 58; *i. e.*, Hindoos 37, Mahommedans 16, Christians 5. Find, to the first place of decimals, the percentage of *attendance*, both on the aggregate, and of each class of pupils.

1860.

1. Multiply 76489 by 743, and explain fully the various steps of the process.

In what cases does multiplication increase, leave unaltered, diminish, the multiplicand ?

2. Find the least common multiple of 2191, 1252 and 1878. Illustrate the proof of your rule by this example.

3. What decimal of 9*s*. 3*d*. will be equivalent to a rupee, when the exchange is at 1*s*. 10½*d*. ?

4. Find the vulgar fraction which will represent in the simplest manner

$$\frac{5\cdot75}{4\cdot25} \text{ of } \tfrac{1}{4} \div \tfrac{2}{7} + \tfrac{1}{9} \cdot \tfrac{2}{3} \cdot \tfrac{1}{2}.$$

5. Extract the square root of 1156·272016.

6. If a cloth, 4 yards long and 15 inches wide, cost R3. 5*a*., how much should you give for a cloth 19 yards long, 12 in. wide, and every square inch of which is worth $\frac{5}{6}$ths of the value of a square foot of the former.

1861.

1. A bankrupt is indebted to *A*, *B*, *C*, and *D* ;—*A*'s debt is twice *B*'s : *B*'s three times *C*'s ; *C*'s half *D*'s. How much should each receive of assets to the amount of R45,680 ?

2. Add together $\frac{4}{9}$, $\frac{7}{12}$, $\frac{2}{3}$ and $\frac{1}{6}$ and fully explain the process.

3. Reduce to their simplest forms

$$\frac{\frac{7}{9} - \frac{1}{6}}{3\frac{3}{4} + 4\frac{1}{3}} \text{ and } \left(\frac{9-4}{5} \div \tfrac{3}{7}\right)^{2}.$$

4. Multiply ·892 of R16. 5*a*. 4*p*. by 4·278.

5. How much should you pay for a bill on London for £047 when the exchange is at 1*s*. 11¾*d*. ?

6. Divide 764·0468 by ·0007. Give the rule for the position of the decimal point in your quotient and shew that the rule is correct.

7. What is the square root of ·004225.

8. If the daily wages of a labourer rise from four and three-quarters to six annas, what percentage of the increase in the price of food and other commodities will cause his position to be unaltered ?

9. A gentleman buys a house for R24650 and spends 23 per cent. in additions and improvements. At what monthly rental will he secure 8 per cent. per annum on his whole investment ?

1862.

1. Explain the decimal system of numeration. Write in words 14006, 3179340601, and 17·0461.

2. "Multiplication is a shortened form of addition" of all additions, or of some, and if only of some, of what kind ?

Do the two statements *twice two are four* and *four times five are twenty*, rest upon the same ground ? Could you shew without reference to the multiplication table, that five times five must exceed four times six by one ?

3. State and prove the rule for the division of vulgar fractions : divide

$$\frac{1\frac{4}{7}}{6\frac{2}{3}} \text{ by } \frac{19\frac{1}{4}}{\frac{7}{9}}.$$

4. Find the greatest common measure of 323 and 391.

5. If, when the exchange is at 1*s*. $11\frac{1}{2}$*d*. per rupee, you wish to remit R4,891. 4*a*. 3*p*. to London ; what should be the amount of your bills in English money ?

6. Reduce $\frac{4}{7}$ to decimals. Prove the correctness of your method.

7. Find the square root of 64·064.

8. A steam-ship whose speed averages 14 miles an hour, reaches a certain port in 12 days ; how many days afterwards will a sailing vessel arrive, which started at the same time and sailed on an average 8 miles an hour ?

9. A train has been travelling 20 miles an hour : the steam-power is doubled, whilst from various causes the resistance of the train is increased by one-half. (The original steam-power is three times the resistance.) At what rate will the train now travel ?

1863.

1. Divide 480813 by 245 in two ways,

(1) by long division, (2) by factors.

2. Add together £7. 16*s*. 9*d*. ; £19. 4*d*. ; £3. 2*s*. $6\frac{1}{4}$*d*. ; R142. 3*a*. 10*p*. ; R354. 4*a*. 8*p*. ; R1269. 14*a*. 2*p*. ; (1) in English money (2) in Indian money, one rupee being equal to two shillings.

3. Simplify the following fractions :—

(1) $\frac{7887}{7953}$, (2) $\frac{3}{5}$ of $\frac{4}{9}+8\frac{1}{2}+\frac{\frac{1}{2}-\frac{1}{3}}{\frac{1}{3}+\frac{1}{8}}$,

(3) $\frac{3}{4}$ of R9 + $\frac{5}{8}$ of 10*a*. − $\frac{3}{5}$ of 6*p*.

4. Multiply 4·37 by 1·01 and divide 7·4 by ·018.

5. Reduce £56·125 to the ordinary notation.

6. Find the square root of (1) 127449 ; (2) of 12·7449 ; (3) of 2 to three places of decimals.

7. Shew that no number can be a perfect square which has an odd number of decimals after the point.

8. How must R1075 be divided betwixt two persons, so that one may have twice as much as the other ?

9. A sailing vessel reaches Madras from Calcutta in 6 days ; a steamer whose speed is to that of the sailing vessel as 3 : 2 starts at the same time,

but meets with detentions that average 6 hours daily. Which will reach Madras first? And by how much?

1864.

1. A man rides at the rate of 11 miles an hour, but stops 5 minutes to change horses at the end of every 7th mile: how long will he take to go a distance of 94 miles?

2. How are vulgar fractions compared in regard to magnitude? Of the fractions $\frac{7}{24}$, $\frac{11}{38}$, which is the greater and what is the difference?

3. A cubic foot of air weighs 1·29 oz. avoirdupois. What will be the weight of air in a room 18 feet broad, 30 feet long, and 16 feet high?

4. Simplify the expression

$$\frac{\frac{1}{2}+\frac{1}{3}}{\frac{1}{4}+\frac{1}{5}}+\frac{1}{3}\text{ of }{\cdot}4.$$

5. What will be the cost of a beam of wood 14 feet long, 16 inches broad, and 9 inches thick, at R1 . 0 . 8 per cubic foot?

6. Extract the square roots of $17\frac{1}{64}$ and ·015129.

7. Find (by Practice) the value of 371 articles at 6s. 3d. each.

8. Express in a decimal form

$$3+\frac{4}{10}+\frac{0}{1000}+\frac{17}{10000}.$$

9. A train starts from A at 12 o'clock and runs towards C, which is 100 miles distant, at the rate of 30 miles an hour; at the same time the mail cart starts for C, from B, which is half way between A and C, and runs at 10 miles an hour: at what distance from C will it be overtaken by the train?

1865. A.

1. Find (by Practice) the value of $237\frac{1}{4}$ yd. of cloth at 1s. $10\frac{1}{2}d.$ per yard.

2. A person goes into a bookseller's shop with a certain sum of money, and after buying 20 books at R2 . 4 . 0 each, finds that $\frac{5}{8}$ of his money remains. How much had he when he entered the shop?

3. Reduce to their simplest forms each of the following expressions, and show that the second is double of the first—

$$(1)\quad \frac{8\frac{1}{3}}{\frac{1}{5}\text{ of }2{\cdot}25}\text{ of }\frac{{\cdot}1625}{\frac{1}{16}\text{ of }5\frac{4}{7}}\div\left(\frac{2}{21}+\frac{7}{81}\right).$$

$$(2)\quad \left\{37+\frac{3{\cdot}7\dot{0}3\dot{7}}{100}\right\}\times{\cdot}54.$$

4. A room is 16 ft. 5 in. long and 19 ft. 7 in. broad, and the cost of painting the walls at 7a. 6p. per square yard is R43 . 3 . 0. Required the height of the room.

5. Extract the square roots of $5\frac{5}{8}$ and ·0045, each to 4 places of decimals.

6. A merchant buys goods for £568. 4*s*., and sells half of them at a gain of 1*d*. in the shilling of the cost price, one-third of them at a gain of 2*d*. in the shilling and the remainder at a gain of £15. 15*s*. 8*d*. How much per cent. does he gain on the whole transaction?

7. Express $\frac{3}{8}$ of 12*s*. 6*d*. + ·625 of 7*s*. 6*d*. – $\cdot 5\dot{0}\dot{5}$ of 16*s*. 6*d*. as a decimal of £1.

8. A person after paying an income-tax of 1 anna in the rupee, devotes $\frac{1}{16}$ of the remainder of his income to purposes of charity, and finds that he has ₨5,175 left; what is his income?

1865, B.

1. A person paid a tax of 10 per cent. on his income, and had ₨15,000 per annum remaining. What was his income?

2. Find, by Practice, the time of building a wall 27 yards long by 6 feet high, of which one square yard is built in 3 hr. 18 min. 45 sec.

3. How much will 3,630 square yards of land cost when an estate of 144 acres is worth ₨46275?

4. Simplify the expression $\dfrac{\frac{5}{6} \text{ of } \frac{15}{2} + \frac{1}{2} \times 2\cdot\dot{3}}{3 - (\frac{2}{5} + \frac{7}{10}) \div 2\cdot\dot{3}\dot{6}}$.

5. If 10 compositors who can set 3 letters in 5 seconds, finish 27 pages in an hour and a half, how many compositors who can set 5 letters in 6 seconds, will complete 50 pages in an hour?

6. What is the value of

(*a*) $\frac{3}{8}$ of 1*s*. + $\frac{7}{10}$ of 2*s*. 6*d*. + $\frac{3}{8}$ of £1 expressed in the fraction of a guinea?

(*b*) ·0625 of ₨$10\frac{2}{3}$?

7. Find the square root of (*a*) 53·4361, (*b*) $\cdot 18\dot{7}$.

8. *A* can do a piece of work in 3 days, *B* can do 3 times as much in 8 days, and *C* 5 times as much in 12 days. In what time will they do it together, supposing them to work at the rate of 9 hours a day?

1866.

1. One inch of rain falls on an acre of ground. How much will it weigh reckoning the weight of one cubic foot as 1000 ounces?

2. A person bought a horse for ₨750 and kept it 15 months. It cost during that time, in gram, ₨190. 10*a*. 6*p*.; in servant's wages ₨135; and in other expenses ₨35. 14*a*. 6*p*. He sold it for ₨625; what was the average monthly cost of the horse?

3. Reduce to its simplest form

$\dfrac{\frac{5}{8} - \frac{2}{5}}{\frac{4}{5} - \frac{1}{4}}$ and convert the result into a decimal.

4. A body of 3249 men is formed into a solid square. How many men will there be in each side?

5. What fraction of a rupee and a quarter is $\frac{3}{4}$ of $\frac{5}{9}$ of R5. 4*a.* ?

6. Extract the square root of 196·1 to three places of decimals.

7. A merchant clears 20 per cent. on a gross income of R50,000. How much per cent. must he clear if he receives the same amount from a gross income of R40,000 ?

8. A ship-captain owns $\frac{3}{8}$ of his vessel. In virtue of his command he receives $\frac{1}{25}$ of the profits, and of the remainder his share as proprietor, What proportion of the whole does he receive ?

9. A person with a monthly income of R264 spends as much in 4 months as he earns in three. After twelve years he divides his savings amongst his three children in such a manner that the eldest has twice as much as the second, and thrice as much as the youngest. How much did each receive ?

1867.

1. If 16 men can do a piece of work in 255 days, how many men can do the same in 17 days ?

2. How much carpet $2\frac{1}{8}$ feet wide would be required for covering the floor of a room 28 ft. long and $16\frac{1}{6}$ feet wide ?

3. Reduce to its simplest form : $\dfrac{1\frac{1}{2} \text{ of } 2\frac{1}{4} \text{ of } 3\frac{1}{8} \text{ of } 4\frac{1}{6}}{3\frac{3}{8} \text{ of } 2\frac{5}{11}}$.

4. Find the square root of ·0082646281o.

5. A man buys 16 lb. of tea at R2. 2*a.* per lb., also 12 lb. at R2. 5*a.* 4*p.* per lb. ; and 24 lb. at R2. 6*a.* 10*p.* per lb. At what price per lb. must he sell the mixture so as to gain R35. 12*a.* on the whole ?

6. If it is high water at noon on a certain day, find after how many days it will again be high water at noon, supposing the time of high water to be three quarters of an hour later every day.

7. A crow wishing to quench its thirst came to a vessel which contained 28 cubic inches of water. The crow being unable to reach the water picked up several small stones, each three quarters of a cubic inch in size, and let them drop into the vessel until the water came to the top of the vessel. If the size of the vessel was such that it would exactly hold 73 cubic inches of water, find the number of stones dropped in by the crow.

8. A book containing between 900 and 1,000 pages is divided into four parts, each part being divided into chapters. The whole number of pages in each of the four parts is the same. Each chapter in the first part contains 20 pages, each chapter in the second 40, each chapter in the third 60, and each chapter in the fourth 80. Find the whole number of chapters in the book.

1868.

1. Simplify $(\frac{1}{16} \times 3\frac{1}{4}) + (\frac{3}{8} \div \frac{27}{64}) - \left(\frac{1}{1\frac{1}{7}} - \frac{7\frac{3}{5}}{9}\right)$

2. The difference in the values of the two shares into which a certain

property is divided is £48·575 and one share is ·51 of the whole. Find the value of the property and of each share.

3. What is the income corresponding to an Income-Tax of 25 guineas at the rate of 7*d.* in the pound ?

4. Find, to within a foot, the length of the fence enclosing a square field whose area is $3\frac{1}{2}$ acres.

5. A barrack for 30 men is $73\frac{1}{3}$ feet long and $24\frac{3}{4}$ feet broad ; how high should it be to allow each man 1000 cubic feet of air or space ?

6. A person sets out to walk 26 miles ; for a quarter of the distance he goes at the rate of 5 miles an hour, for half the remaining distance at 4 miles an hour, and 3 miles an hour for the other half. State the exact time occupied in the journey.

7. The Fort-Barracks are lighted with gas from 100 burners. Find the cost of lighting them per night of 10 hours, at the rate of R$5\frac{1}{2}$ for 1000 cubic feet of gas, assuming that for the first 3 hours each burner consumes 1 cubic inch per second, and during the remainder of the night the light is so reduced that the consumption of gas by each burner is only $\frac{3}{4}$ths of that quantity per second.

8. If two Malabar miles are equal to 1 kros, and 7 Malabar miles are equal to 10 English miles, how many kros are there in 25 English miles ?

9. A contractor bought 2250 pharas of unslaked lime at Madras at the rate of 45 rupees for 100 pharas. On slaking it every phara gave 3 cubic feet of lime, but of this $\frac{1}{15}$th was unserviceable ; the carriage of the remainder to the place where it was required (distant 18 miles) cost 4 annas per 100 cubic feet per mile. At what rate per cubic foot must he sell it there, in order to gain 90 rupees on his outlay ?

1869.

1. Which is greater

$$\tfrac{3}{5} \text{ of } \tfrac{17}{16} - \frac{1\frac{2}{3}}{6\frac{2}{3}} \text{ of } \tfrac{19}{20} + \tfrac{8}{7} \text{ of } \frac{6\frac{5}{19}}{3\frac{2}{3}} \text{ or}$$

$$\tfrac{2}{3} \text{ of } \tfrac{13}{16} + \frac{6\frac{2}{3}}{1\frac{2}{3}} \text{ of } \tfrac{19}{20} - \tfrac{7}{5} \text{ of } \frac{6\frac{5}{19}}{3\frac{2}{3}} \text{ ?}$$

and express the difference as a decimal.

2. Express as a fraction the difference between $\frac{355}{113}$ and 3·1416 ; and reduce 2 tons 3 cwt. 2 qr. 26·995954 lb. to the decimal of a bis of 3·086 lb.

3. A rectangular field, whose diagonal measures 825 feet, has one of its sides ·75 of the length of the other. Find the length of each side in yards, and the area in acres.

4. A person had a legacy left to him which he thus divided amongst 3 charities. To one he gave $\frac{5}{11}$, to the second $\frac{4}{7}$ of the remainder, and to the third $\frac{3}{4}$ of what now remained ; and he then had 1,500 rupees left. Find the amount of the legacy, and how much was given to each charity.

5. A creditor received on a debt of 3.600 rupees a dividend of 9*a*. 10*p*. in the rupee; and a further dividend of 6*a*. 8*p*. upon the remainder. What did he receive altogether, and what fraction was it of the entire debt?

6. *A* and *B* each lends £250 for three years, *A* lends at $4\frac{3}{4}$ per cent. simple interest, and *B* at $4\frac{1}{2}$ per cent. per annum, compound interest. Find the difference in the amount of interest they receive.

7. A contractor agrees to supply $10\frac{1}{2}$ lacs of bricks for a particular work. His bricks cost him $3\frac{1}{2}$ rupees per 1,000 to make, and of these $12\frac{1}{2}$ per cent. are rejected. How many bricks must he make in order to fulfil his contract, and what price per 1,000 must he put on those supplied in order to gain 25 per cent. on his outlay?

8. The distance by Railway from Madras to Salem is $206\frac{1}{4}$ miles. A Passenger Train travelling 20 miles an hour leaves Madras at 7 A. M.; and a Special Train at 10 A. M. the same day. At what rate must the latter travel, so as just to overtake the former at Jollarpett Junction (132 miles from Madras) and at what hour must a Goods Train leave Salem for Madras travelling 15 miles an hour, so as to reach Jollarpett at the same time as the other trains?

9. Extract the square root of

$$\frac{1\cdot\dot{7}+29\frac{4}{9}}{\cdot000729}$$

10. A work can be completed in 35 days by 30 men working 6 hours a day; in what time would 18 men and 60 women working 9 hours a day complete it; supposing that 3 men can do as much as 5 women; and that in the longer days a man does only $\frac{4}{5}$ per hour of what he does per hour in the shorter days?

1871.

1. A person mixes together 10 lb. of tea at R1. 4*a*. a lb., 12 lb. at R1. 6*a*. and 14 lb. at R1. 8*a*. a lb. He reserves 6 lb. of the mixture for himself and sells the remainder at R1. 13*a*. 4*p*. a lb. How much does he gain?

2. (*a*) Simplify $\dfrac{1}{1-\dfrac{2}{2-\frac{1}{2}}} - \{\frac{1}{2}-(1+\frac{1}{12})\} \div 3(1-\frac{3}{8} \text{ of } 2\frac{1}{4})$.

(*b*) Express $\frac{3}{8}$ of $\frac{8}{15}$ of £1. 10*s*. + $\frac{3}{4}$ of $\frac{5}{8}$ of 5*s*. 4*d*. − $8\frac{1}{2}$ of $\dfrac{1}{4\frac{1}{4}}$ of 5*s*. $3\frac{3}{4}d$. as the fraction of 2*s*. $1\frac{1}{2}d$.

3. *A* has shares in an estate to the amount of $\cdot15+\cdot\dot{3}\dot{6}$ of it. *B* has shares in the same estate to the amount of $\cdot4\dot{7}\dot{2}$ of it; find the difference in value between the properties of *A* and *B*, when $\cdot0\dot{5}\dot{6}$ of the estate is worth £373·3.

4. A reduction in the income-tax diminishes a tax which is R15 when the tax is 8 pies in the rupee by R3 . 12 . 0; what is the diminished rate of the tax in the rupee?

5. 23 cwt. 3 qr. 7 lb. are bought at £2. 10s. 8d. per cwt. and 72 cwt. 2 qr. 8 lb. at £2 . 7 . 10 per cwt. Find, by Practice, the amount expended and give average price per lb.

6. A person borrows £500 at 5 per cent. per annum, and subsequently £400 at $3\frac{1}{2}$ per cent., if the amount of both sums 6 months after the latter was borrowed is £957, find the time for which interest is paid on the former sum.

7. A cask of $144\frac{3}{8}$ gallons is bought for £50 and kept 10 years, during which $\frac{1}{15}$ of a gallon evaporated yearly; at what rate per gallon must the contents be sold so as to clear 20 per cent. on the amount of the original outlay at 4 per cent. per annum simple interest?

8. Water flows into a rectangular cistern whose dimensions are 12 ft. 1 in. long, 11 ft. 8 in. wide, and 5 ft. 4 in. deep, through a pipe of 10 sq. inches aperture at the rate of $2\frac{1}{2}$ ft. per second, and flows out through an orifice at the rate of 2 ft. 5·8 in. per second; if the cistern is filled in two hours, find the size of the orifice.

9. A lump composed of gold and silver measures 6 cubic inches and weighs 100 oz.; if a cubic inch of gold weighs 20 oz. and an equal bulk of silver 12 oz., find the weight of gold in the mixture.

10. A train which travels at the uniform rate of 30·8 ft. a second leaves Madras at 7 A. M.; at what distance from Madras will it meet a train which leaves Arconum for Madras at 7-20 A. M. and travels one-third faster than it does, the distance from Madras to Arconum being 42 miles?

1872.

1. How much water must a person add to a cask containing a mixture of 12 gallons of spirits at 12s. 6d. a gallon and 8 gallons at 10s. 6d. a gallon, in order to gain £2. 6s. on his outlay by selling the contents at 10s. a gallon?

2. Simplify

(a) $$\frac{2}{9} \div \left\{ \frac{\frac{28}{81} \text{ of } \frac{1}{9\frac{1}{3}}}{\frac{4}{5} - \frac{3}{4}} \right\} - \frac{1}{3} \text{ of } \left\{ \frac{1}{2} - \frac{5}{6} \text{ of } \frac{1}{3 - \frac{1}{1 - \frac{2}{9}}} \right\}.$$

(b) $$\frac{\cdot 12 \text{ of } (\cdot 0123 - \cdot 004) + \cdot 36 \times \cdot 003}{\cdot 2 \times \cdot 3 \times \cdot 17}$$

3. A person going from Madras to England pays R600 for his passage to Brindisi: his journey from Brindisi to Dover occupies 10 days, and his average daily expenses during that period are 55 francs. He remains 36 days in England, spending on the average 30 shillings daily and pays £65 for his return-passage to Madras. If 25 francs and $10\frac{1}{2}$ Rupees be each equivalent to £1; find in Rupees his total expenses

4. Express ·125 of 1·6s. + $\cdot 5\dot{2}\dot{7}$ of 4s. 7d. as the decimal fraction of £$39\frac{3}{4}$.

(a) Extract the square root of ·0001950 and of $4\frac{247}{1681}$.

5. A house which cost R15,000, lets for R130 a month; the annual

assessment amounts to $1\frac{1}{2}$ per cent. on its cost, and the outlay for repair to a month's rent. What rate of interest does it pay?

6. A person's income derived from an investment which pays 5 per cent. interest is R3,800 after an income-tax of 2 pies in the Rupee has been deducted. Determine the amount invested.

7. A bankrupt has debts due to him exceeding his liabilities by one-fifth; but on half of these debts he can recover only 4 $8\frac{2}{3}$ annas in the Rupee, and the expenses of bankruptcy are 4 per cent. on the amount which he recovers. What dividend does he pay?

8. The external length, breadth and depth of a rectangular closed tin vessel are 14, 10 and 9 inches respectively, and the thickness of the tin $\frac{1}{4}$ an inch; when the vessel is empty, it weighs 1,500 oz. and when filled with water, 2041·6 oz. Find the weight of a cubic foot of water.

9. *A* gave R57. 8*a.* for two first and three second class railway tickets from Madras to Bangalore, and *B* gave R4-1*a.* and R1-2*a.* for one first and one second class ticket respectively from Madras to Arconum. Find the first class fare from Madras to Bangalore, the fare being proportional to distance.

10. A train running at the rate of 40 miles an hour meets a person walking along the line in the opposite direction at the rate of 4 miles an hour and passes him in $5\frac{3}{4}$ seconds; find the length of the train. Had the person been going in the same direction as the train, in what time would it have passed him?

1873.

1. A person buys a piece of land at £25 an acre, and by selling it in allotments finds that the value is increased by one-half, so that, after reserving 20 acres for himself, he clears £200 on his purchase money by the sale of the remainder. How many acres were there?

2. Simplify

(*a*) $\dfrac{7}{5-\frac{5}{8}} \div \dfrac{3-\dfrac{2}{3-\frac{3}{5}}}{4-\frac{3}{5}} - \frac{2}{7}$ of $\left\{\dfrac{1}{1\frac{3}{7}} + \frac{8}{5} \text{ of } \dfrac{3\frac{1}{8}-2\frac{1}{3}}{4\frac{7}{21}-2}\right\}$.

(*b*) Reduce $(\cdot 5\dot{7}\dot{5} + 16 \times \cdot\dot{1}\dot{5})$ of 4 viss to the decimal of $1\frac{11}{28}$ cwt., a viss being equal to 3 lb. 2 oz. avoirdupois.

3. A vessel's cargo, $\frac{2}{3}$ of which is worth £$6666\cdot\dot{6}$, gets damaged, and the owner in consequence sells $\dfrac{\cdot 8\dot{3} + \cdot 041\dot{6}}{1\cdot 05}$ of it for half the original value of the whole cargo. What is the value of the remainder at the same rate and what the loss on the whole cargo?

4. Find how much rice a family requires monthly, when a reduction in the price from 7 to 10 measures for the rupee reduces the total monthly expenses from R$31\frac{1}{4}$ to R30.

5. A person going from Pondichery to Ootacamond travels 90 miles by steamer, 230 miles by rail and 30 miles by horse-transit. The journey

occupies 30 hours 50 minutes, and the rate of the train is three times that of the horse-transit and $1\frac{1}{2}$ times that of the steamer. Find the rate of the train.

6. A person bought 10 Bank of Madras shares at R1540 each, and for 5 years got interest on his investment at the rate of $5\frac{1}{2}$ per cent. He then sold his shares at a loss of $22\frac{1}{2}$ per cent. How much did he make by the transaction, and what rate per cent. per annum had he for his money?

7. A person borrows two equal sums at the same time at 5 and 4 per cent. respectively, and finds that if he repays the former sum with interest on a certain date 6 months before the latter, he will have to pay in each case the same amount, *viz.* £1100. Find the amount borrowed and the time for which interest is paid.

8. A dealer buys 10 horses at R400 each, 8 horses at R500 each, and 4 horses at R600 each. He keeps the horses for 6 months, during which each costs R15 a month, and then sells them, clearing $12\frac{1}{2}$ per cent. on his original outlay, after paying his expenses. Find the selling price.

9. A stream of water, 8 yd. broad at the surface and 6 yd. at the bottom and 2 yd. deep, flows at the rate of $1\frac{1}{2}$ miles an hour, into a tank, 220 yd. long and 56 yd. broad, which holds 74,250 tons of water. Find the depth of the tank and the time in which it will be filled, a cubic foot of water weighing 1,000 oz.

10. Two trains, running at the rates of 25 and 20 miles an hour respectively, on parallel rails in opposite directions, are observed to pass each other in 8 seconds, and when they are running in the same direction at the same rates as before, a person sitting in the faster train observes that he passes the other in $31\frac{1}{2}$ seconds; find the lengths of the trains.

1874.

1. Find the greatest number which will divide 201 and 671, leaving remainders 6 and 8 respectively; and the least number which when divided by 5, 7 and 9 gives in each case a remainder 4.

2. A wine merchant mixes together one pipe (126 gallons) of wine at £80, one at £90, and one at £100, and sells one-third of the mixture at 13*s.* 4*d.* a gallon; at what price per gallon must he sell the remainder so as to gain £$34\frac{1}{2}$ by the transaction?

3. Simplify

(*a*) $\left\{\dfrac{2}{3-\dfrac{1}{1-\frac{1}{2}}}-\frac{1}{3}\text{ of }\left(5-\dfrac{2}{\frac{3}{2}-\frac{1}{6}}\right)\right\}\div\dfrac{\frac{1}{2}+\frac{3}{4}}{1\frac{1}{3}}.$

(*b*) $\dfrac{\cdot1\times\cdot1\times\cdot1+\cdot01\times\cdot01\times\cdot01}{\cdot2\times\cdot2\times\cdot2+\cdot02\times\cdot02\times\cdot02}.$

4. Find the value of $\cdot\dot{4}2857\dot{1}$ of £$1\cdot05+\cdot3\dot{8}$ of $1\cdot5$*s.*, and express the result as the decimal of £43. 2*s.* 6*d.*

5. *A* barters sugar with *B*, for rice which is worth $1\frac{3}{4}$ annas a measure, but in weighing his sugar uses a false maund weight. *B* discovers this,

and to make the exchange fair raises the price of his rice to $2\frac{1}{2}$ annas a measure. Find the real weight of the false maund which *A* uses.

6. A certain sum put out at compound interest amounts in two years to £270·4, and in three years to £281·216. Find the sum and the rate per cent.

7. A person pays an income-tax of 4*d.* in the £ during the first half of the year, and of 3*d.* in the £ during the second half and finds that owing to an increase in his income he pays the same amount of tax for the second as for the first half of the year. If his gross income for the year is £700, find his net income.

8. A cistern measuring 13 feet in length, 5 feet in breadth, and 4 feet in depth, has a tap which, not being properly opened discharges 54 gallons an hour less than it would otherwise do and empties the cistern in $7\frac{1}{2}$ instead of 6 hours. How many cubic inches are there in a gallon?

9. Gold costs £3. 17*s.* $10\frac{1}{2}d.$ per oz., and silver 5*s.* 6*d.*; in what proportion must these metals be mixed that a lb. of the mixture may be worth £32. 5*s.*?

10. A peon walks from *A* to *B* at the rate of 3 miles an hour, and after transacting some business which occupies him an hour, returns to *A* by the tramway at the rate of 5 miles an hour. He then finds he has been absent 2 hours 20 minutes. Find the distance from *A* to *B*.

1875.

1. A merchant purchases 231 gallons of spirits at R10. 12*a.* 4*p.* per gallon; 126 gallons at R12. 11*a.* 7*p.*; and 79 gallons at R14. 8*a.* 9*p.*: if he sell the mixture at R13 per gallon, how much will he gain by the transaction?

2. Define a decimal; and show how its value is affected by affixing and prefixing cyphers.

Reduce $\dfrac{1+\dfrac{2}{3\frac{1}{3}}}{1-\dfrac{2}{3\frac{1}{3}}} \div \left\{1+\dfrac{1}{9-\dfrac{3}{1-\frac{5}{8}}}\right\}$ to a decimal,

and find the value of $\dfrac{\cdot044\times2\cdot1}{\cdot000035}\div\dfrac{3\cdot\dot{0}7692\dot{3}}{2\cdot\dot{3}\times5\cdot\dot{6}}$.

3. Express the sum of $\cdot\dot{5}7142\dot{8}$ of a viss, $\frac{3}{8}$ of $\dfrac{1}{3\frac{3}{8}}$ of $\dfrac{317}{384}$ of a maund and $\frac{3801}{10160}$ of a hundredweight as a decimal of one ton. (One viss = 3 lb. 2 oz.; one maund = $82\frac{2}{7}$ lb.)

4. If 210 coolies in 7 days of 10 hours each dig a channel 1 mile long, 6 feet broad, and 2 feet deep; in how many days of 7 hours each should 35 coolies dig a channel 660 feet long, $7\frac{1}{2}$ feet broad, and $2\frac{1}{4}$ feet deep? And how many cubic feet does each cooly dig in an hour?

5. The expenses of a family when rice is 12 seers for a rupee are 50 rupees a month: when rice is 14 seers for a rupee the expenses are

48 rupees a month (other expenses remaining unalterable); what will they be when rice is at 16 seers per rupee?

6. What are the prime factors in 45090045, and what is the smallest whole number by which it must be multiplied in order to become a perfect square?

7. The cost of carpeting a room is £7. 4s., and of papering the same room, with paper at $2\frac{1}{2}d.$ per square foot, £10. 12s. 6d. The length of the room is 18 feet, and if the width had been 4 feet less, the cost of the carpet would have been £1. 16s. 0d. less. Find the height of the room.

8. Find the sum of which the difference between the simple and compound interest at 5 per cent. per annum for 3 years, is £12. 4s. 0d.

9. What length of wire will go round the edges of a cube the surface of which contains 187 yards 54 inches?

What is the least number of such cubes which will contain an exact number of cubes whose edges are 1 foot 3 inches?

10. A merchant's average rate of profit for five years was 5 per cent. on his capital, and for the first four years his average profit was 4 per cent. What was his rate of profit in the fifth year?

1876.

1. *A* and *B* run a mile race, *A* running 11 yards whilst *B* runs 16 yards. How many yards start ought *B* to give *A* that they may reach the winning post at the same instant?

2. In buying rice on three occasions, I found the prices per bag were as 1 : 2 : 3 respectively. The price of 30 bags, 10 bought on each day, was R480. Find the price per bag on each day.

3. The length of a room is $30\dot{1}4285\dot{7}$ feet, the breadth is $15\dot{4}2857\dot{1}$ feet, and the height 21 feet. Find the cost of papering the four walls at ·16 annas the square foot.

4. If a piece of work can be done by 30 men in 12 days, and if after working 4 days, 18 men leave the work, and 18 women take their places: find the time taken to do the remainder of the work, the work of a man being half as much again as that of a woman.

5. In a railway train the total lengths of all the first-class carriages, all the second-class carriages, and all the third-class carriages, are the same: the length of a first-class carriage being 12 feet, of a second-class carriage 18 feet, and of a third-class carriage 24 feet. Each first-class carriage contains the same number of first-class passengers, each second-class carriage the same number of second-class passengers, and each third-class carriage the same number of third-class passengers; the number of passengers in a first, second, and third-class carriage being different. The total fares received from the first-class, second-class, and third-class passengers are the same. If R5, R3, R2, be the fares of a 1st, 2nd, and 3rd class passengers respectively, find the least amount of total fares.

6. Find, by Practice, the cost of 140,321 articles at 13 annas $11\frac{1}{2}$ pies each.

7. Find the side and diagonal to two places of decimals, of a square containing 315·0625 square feet.

8. Madras Railway shares issued at £100 and guaranteed 5 per cent. are now worth £112. 10*s.* Exchange being at 1*s.* $7\frac{1}{2}d.$ per rupee, find the income in pounds sterling that would be derived from an investment of R18,000.

9. A certain sum of money at simple interest amounts to R505·2 in two years, and to R589·4 in four years. Find the principal and the rate of interest.

10. A material which costs R3 annas 8 per ton, and which has 20 cubic feet to the ton, has to be carried 16 miles at a rate of 6 pies per ton per mile: while another material which cost R2. 4*s.* per ton, and has 16 cubic feet to the ton, has to be carried 36 miles at a rate of 4 pies per ton per mile. What saving can be effected by employing the latter material on 100,000 cubic yards of break water?

1877.

1. A merchant buys 264 gallons of spirit at R12 8*a.* $4\frac{1}{2}p$ per gallon, 378 gallons at R9. 10*a.* 7*p.* per gallon and 420 gallons at R12 15*a.* $6\frac{1}{4}p.$ per gallon. If he sell the whole quantity at R12. 4*a.* 0*p.* per gallon, what profit will he make by the transaction?

2. If 2 men and 5 women can do a piece of work in 8 days of 9 hours each; how long will it take 3 men and 6 women to do a piece of work twice as great working 8 hours a day; the work of a man being double that of a woman?

3. Extract the square root of ·0002890; and find in yards to four places of decimals the side of a square field containing ·254 of an acre.

4. Find the value of $\cdot01\dot{6}$ of R260. 2*a.* 6*p.* + $\cdot\dot{3}5\dot{1}$ of R13. 14*a.* 0*p.* + $1\cdot\dot{0}003\dot{3}$ of R7. 14*a.* 3*p.*

5. A merchant buys cloth at such a price that by selling it at R2. 3*a.* per yard he will gain 5 per cent. on his outlay. What percentage will he lose if the cloth be sold at R1. 13*a.* per yard?

6. Find the interest (simple) at 4 per cent. per annum on R595. 9*a.* for 4 years and 17 weeks, reckoning 52 weeks equal to a year.

7. A sum of R18,240 is remitted to England at the rate of exchange of one shilling and $8\frac{3}{8}$ pence per rupee, and is invested in the 3 per cent. consols at 95. Find the yearly income in pounds sterling.

8 A man bequeathed $\frac{5}{13}$ of his estate to one son, $\frac{7}{16}$ of the remainder to another son, and the balance to his widow. The children's shares differ by R1320; find the widow's share.

9 A merchant buys in Madras 210 bags of rice at R10. 12*a.* 0*p.* per bag of 164 pounds. He sends them by rail 320 miles at $6\frac{1}{4}$ pies per ton per mile, but during the journey $7\frac{3}{4}$ pounds are stolen from each bag. Find at how many measures per rupee he must sell the remainder in order to clear R95. 15*a.* 0*p.* by the transaction. (One measure = $3\frac{1}{4}$ pounds.)

1878.

1. Find by *Practice* the value of

(*a*) 9 tons 17 cwt. 3 qr. 24 lb. at R125. 6*a*. 8*p*. per ton.

(*b*) 29,764 articles at R1. 11*a*. 9¾*p*. each.

2. The materials of an old building were sold for R1,500 upon condition that they should be removed within 30 days under a penalty of R10 per day for every day beyond 30 days. The purchaser employed 40 men at 3½ annas per day to do the work, and after selling the materials for R2365, he cleared R190 by his bargain. Find the number of days the men were at work.

3. (*a*) Divide ·0576 by 180, and by ·018.

(*b*) Find the value of

$$\frac{2\cdot8 \text{ of } 2\cdot\dot{2}\dot{7}}{1\cdot\dot{3}\dot{6}} + \left(\frac{4\cdot\dot{4}-2\cdot8\dot{3}}{1\cdot\dot{3}+2\cdot62\dot{9}}\right) \text{ of } 8\cdot2$$

4. *A* and *B* enter into partnership; *A* supplies the whole of the capital, amounting to R45,000 upon condition that the profits are to be equally divided, and that *B* pays *A* interest on half the capital at 10 per cent. per annum but receives R120 per mensem for carrying on the concern. Find their total yearly profits when *B*'s share is equal to ⅓ of *A*'s share.

5. Find the difference between the *true* discount on R259·2 due two years hence and the interest on the same sum for two years, allowing in both cases simple interest at 4 per cent. per annum.

6. A room 21 feet long by 13½ feet wide is surrounded by walls 1½ feet thick and 14 feet high. There are two doors each 4½ feet by 6 feet, and one window 3 feet by 4½ feet. Find (1) the cost of building the walls at the rate of R5. 1*a*. 0*p*. per cubic yard, and (2) the number of bricks, each measuring 9 in. × 4 in. × 2¼ in., required for the work.

7. If 38 men working 6 hours a day can do a piece of work in 12 days, find in what time 57 men working 8 hours a day can do a piece of work twice as great, supposing 2 men of the first set to do as much work in 1 hour, as three men of the second set can do in 1½ hours.

8. Extract the square root of ·002 and of 764·9, each to four places of decimals.

9. A person's net income from 5 per cent. Government paper is R1225 after paying income-tax at the rate of 2 per cent. Find the number of shares of R1000 each owned by him.

1879.

1. A person purchases 18,426 articles at R2. 8*a*. 9¾*p*. each, and 2,204 articles at R4. 11*a*. 7½*p*. each. He sells the whole number at R2. 13*a*. 0*p*. each. Find how much he gains by the transaction.

2. In 12 days, 20 men could finish a piece of work. Being assisted by 6 women for 5 days, and by 10 women for the rest of the time, the work is done in 9 days. How long would 28 women take to do the work?

3. *A* sold a horse to *B*, who sold it to *C* at a loss of 10 per cent. *C* sold it for R891. and cleared 20 per cent. on his bargain. What did *B* give for the horse, and what gain per cent. was the last price on the first price?

4. Find the value of $\cdot 9\dot{6}$ of R9. 1*a.* 9*p.* + $\cdot 5\dot{9}2\dot{5}$ of R7. 5*a.* 0*p.* + $\cdot 0027$ of R13. 0*a.* 4*p.*

5. Extract the square root of 4·376 and of $\cdot\dot{3}$ each to 4 places of decimals.

6. An oblong piece of ground measures 57 feet 3 inches by 36 ft. 7 inches. From the centre of each side a path 5 ft. 4 inches wide goes across to the centre of the opposite side. Find the cost of paving these paths at the rate of R1. 5*a.* per square yard.

7. On what sum will the difference between the simple and compound interest for 3 years at 5 per cent. per annum amount to R13. 11*a.* $7\frac{1}{5}$*p.*

8. A person in England has a certain sum invested in Indian $4\frac{1}{2}$ per cent. Government bonds, which after deducting 2 per cent. as agent's charges for drawing and remitting the money, and when the rate of exchange is 1*s.* $7\frac{1}{2}$*d.* per rupee, brings him an income of £429. 19*s.* 6*d.* per annum. Find the amount of the investment in rupees.

9. A train 132 yards in length, travelling at a uniform speed, overtook a man walking along the line at the rate of 6 miles an hour, and passed him in 12 seconds. Twenty minutes later the train overtook a second man and passed him in 11 seconds. How many hours after the train overtook the second man would the first man also overtake him?

1880

1. The circumference of a circle being equal to $3\frac{1}{7}$ times its diameter, find the diameter of an engine-wheel which makes three revolutions a second when the engine is moving at 40 miles an hour?

2. If 24 men build a wall $2\frac{1}{2}$ miles long, 2 feet broad, and 6 feet high, in 146 days of 10 hours each, what length of wall $2\frac{1}{2}$ feet broad, and 5 feet high, will 15 men build in 365 days, working 8 hours a day?

3. Express $\cdot 34\dot{5}$ of R16. 0*a.* 8*p.* − $\cdot 07\dot{3}$ of R6. 4*a.* 0*p.* as the decimal of R8. 9*a.* 3*p.*

4. A person sold 86 measures of rice for R13. 7*a.* 0*p.*, thus gaining 15 per cent.; and 154 measures at a profit of 10 per cent. Supposing he had sold the whole at a profit of 16 per cent., how much more would he have gained?

5. The length of a room is $32\frac{1}{2}$ feet. The cost of carpeting the walls at R1. 14*a.* per sq. yd. is R308. 2*a.*; and the cost of carpeting the room at R2. 4*a.* per sq. yd. is R150. 5*a.* Find the height and width of the room.

6. Extract the square root of 6095961. Also of $\cdot 006\dot{2}$ to four places of decimals.

7. Five men start to walk round a race course, which is $1\frac{7}{8}$ miles round. They walk at the rates of 3, $3\frac{3}{4}$, 4, $4\frac{1}{2}$ and 5 miles per hour. How long will it be before they all meet again at the starting point?

8. If R32,000, put out at compound interest, amount in 2 years to R34,279$\frac{1}{8}$, what is the rate per cent.?

9. A person leaves R5,780 to be divided among his 5 children and 4 brothers, so that after the legacy duty has been paid, each child's share shall be twice as great as each brother's share. The duty on a child's share is one per cent., and on a brother's share 4 per cent. Find what amounts they respectively receive.

1881.

1. Find by *Practice* the cost of: –
   8 cwt. 3 qr 12 lb. at R27. 4*a* 4*p*. per cwt.
   7 mi. 5 fur. 165 yd. at R682. 7*a*. 4*p*. per mile.

2. A room measuring 42 feet 6 in. by 22 feet 9 in. inside, with walls 2 feet 3 in. thick, is surrounded by a verandah 10 feet 6 in. wide. Find the cost of paving this verandah with tiles measuring 4$\frac{1}{2}$ in. by 3 in., and costing R3. 2*a*. per hundred.

3. A bankrupt has book-debts equal in amount to his liabilities, but on R8,640 of such debts he can recover only 8$\frac{1}{2}$*a*. in the rupee, and on R6,300, only 5$\frac{3}{4}$*a* in the rupee. After allowing R1,054. 11*a*. for the expenses of bankruptcy, he finds he can pay his creditors 12*a*. in the rupee. Find the total amount of his debts.

4. Extract the square root of 2329$\frac{120}{841}$.
   Also of $\frac{3}{70}$ to four places of decimals.

5. Reduce $\cdot 0\dot{3}\dot{5}$; $\cdot 071875$; $\cdot 3\dot{9}0\dot{9}$; and $\cdot \dot{9}2\dot{5}$ to equivalent vulgar fractions in their lowest terms.

6. A sum of money in 10 years at 3$\frac{1}{2}$ per cent. simple interest amounts to R727. 0*a* 6*p*. In how many years would it amount to R840. 2*a*. at 4 per cent.?

7. Find the cost in rupees of one mile of railway, which consists of two rails each weighing 40 lb per yard on wooden sleepers weighing 70 lb. each placed 2 ft. 8 in. apart. The rails cost in England £6. 13*s*. per ton, and the sleepers 2*s* 4$\frac{1}{2}$*d*. each. The rate of freight is £1. 5*s*. per ton, and landing charges amount to R2 8*a*. per ton. Rate of exchange 1*s*. 8*d*. per rupee.

8. For what sum should a cargo worth R26,315 be insured at 7$\frac{5}{8}$ per cent., so that the owner may recover in case of loss the value both of cargo and the sum paid for insurance?

9. Two trains measuring 330 feet and 264 feet respectively, run on parallel lines of rail. When travelling in opposite directions they are observed to pass each other in 9 seconds, but when they are running in the same direction at the same rates as before the faster train passes the other in 27$\frac{1}{2}$ seconds. Find the speeds of the two trains in miles per hour.

1882.

1. What decimal fraction of a mile is 681 yd. 0 ft. 4$\frac{8}{25}$ in.?

2. Simplify $\left\{ \sqrt[3]{\dfrac{\frac{1}{7}+\frac{1}{8}}{\frac{1}{6}-\frac{1}{7}} + 2\left(\dfrac{\frac{1}{8}+\frac{1}{9}}{\frac{1}{5}-\frac{1}{8}}\right)} \right\}^{2}$.

3. The wheels of a cart are 13 ft. 6 in. in circumference. One breaks down, and is replaced by a new one, which is rather small. To test it, the owner makes a chalk mark on each wheel where it touches the ground, and tells his man to drive over a piece of level road, and to count the turns made by each wheel until the chalk marks next touch the ground at the same time. The man obeys; but, when he returns to his master, can only recollect that one wheel made one more turn than the other. His master, however, measures the distance traversed by the cart, 360 yd., and thence finds the circumference of the new wheel. What is it?

4. Find the value of $\dfrac{15+\sqrt{(\cdot\dot{0}09)}}{1-\sqrt{(\cdot 9)}}$ correct to three places of decimals.

5. (*a*) What is the smallest whole number which is divisible by $3\frac{1}{3}$, 15, and $17\frac{1}{2}$ without remainder?

(*b*) What is the greatest number which will divide 3051 and 2331, leaving remainders of 8 and 4 respectively?

6. The table below shows the marks gained at an examination in seven different subjects by a class of six boys *A*, *B*, *C*, *D*, *E*, *F*. Complete the table so as to show, correct to one place of decimal:—

(*a*) What percentage of the total marks is gained by each boy;

(*b*) What percentage of the marks awardable in each subject is gained by the class;

(*c*) What percentage of the total marks is gained by the class.

———	Arithmetic 85	Algebra 80.	Euclid 70.	English 120.	History 110.	Geography 100.	Hand writing 35.
A	33	27	12	95	79	63	3
B	76	49	52	73	67	82	15
C	48	69	43	61	58	85	21
D	53	41	27	91	61	47	23
E	71	62	39	85	73	68	14
F	47	18	21	78	92	27	12

7. Divide $5\cdot8\dot{9}551$ by $13\cdot7\dot{5}85\dot{4}$, expressing the quotient as a decimal.

8. A Bank advances R1,500 to a person on agreement that interest at the rate of 9 per cent. per annum shall be paid half-yearly for its use. The person fails to make any interest payment, and at the end of eighteen months, the Bank obtains judgment against him for the principal and compound interest at the rate and on the terms agreed to. Find to the nearest pie the amount he has to pay.

9. The roof of a verandah is supported by 16 teak-beams, each 9 ft. long, 3 in. broad, and 5 in deep. If the weight of a cubic inch of teak is $\frac{18}{25}$ of that of a cubic inch of water, and if a cubic foot of water weighs 1,000 oz., find the weight in lb. of the timber in the verandah.

1883.

1. A cistern, whose capacity is 43,092 gallons, is to be filled with water by a pipe which conveys 23 gallons 1 qt. per minute. On account of a leakage, the cistern is only just filled in $31\frac{1}{3}$ hours. What is the average amount of leakage per hour?

2. I sold some goods, weighing 13 cwt. 2 qr. 9 lb. for £72. 17*s* $7\frac{1}{2}$*d.*, gaining thereby $3\frac{1}{2}$*d.* per lb. How much should I have gained per lb. if I had sold them at £5. 12*s.* per cwt.?

3. If 40 men and 50 boys can do a piece of work in 6 days, working 6 hours a day, in how many days will 8 men and 20 boys, do a piece of work half as large again, working 7 hours a day, assuming that a man does as much work in 3 hours as a boy in 5 hours?

4. Three equal circular wheels revolve round a common horizontal axis with different velocities. The first makes a revolution in $5\frac{3}{8}$ minutes, the second in $2\frac{2}{7}$ minutes, the third in $3\frac{3}{7}$ minutes. Three marks, one in each wheel, are in a horizontal line at a certain moment. What is the shortest interval after which they will be in a horizontal line again?

5. Find, by Practice, the cost of 475 tons of coal at £2. 16*s.* 8*d.* per ton. If this is sold again for £1,453. 10*s.*, what is the whole gain, and what the gain per cent.?

6. *A* and *B* start on a journey at the same time. *B* travels at $\frac{4}{7}$ths of *A*'s rate, and arrives 3 hours 15 minutes after him. In what time did each complete the whole journey?

7. If an investment of £75 becomes £78. 15*s.* in eight months, what sum, invested at the same rate of interest, will become £201. 17*s.* 6*d.* in ten months?

8. Simplify the expression :—

$$\frac{\sqrt{(75\frac{1}{9})}-6\frac{7}{8}\text{ of }\dot{7}\dot{2}}{5\frac{5}{9}-\sqrt{(2\frac{34}{81})}}-\frac{10\frac{2}{11}}{3\cdot\dot{3}\dot{9}\times 3}.$$

9. *A* and *B* started on a race and ran a certain distance exactly together. Then *B* began to fail and gave up the race when he had run 56 yards further, *A* having gone during the same time 320 yards. The average of the entire distances run by the two men was 1,188 yards. What distance had they run together?

1884.

1. Simplify $\frac{5\frac{3}{8}+4\frac{5}{8}}{8\frac{5}{6}-5\frac{2}{7}}\div\left\{\frac{\frac{7}{8}-\frac{5}{7}+\frac{5}{8}}{\frac{8}{7}-\frac{7}{6}+\frac{9}{8}}\text{ of }(1\frac{3}{11}\times 3\frac{1}{3})\right\}$.

2. Find, by Practice, the cost of 15 tons 11 cwt. 3 qr. 10 lb. 8 oz. at ₨93. 5*a.* 4*p.* per ton.

3. Extract the square root of $1\frac{2}{5}$, to five places of decimals; and divide $1\cdot 43\dot{8}$ by $\cdot 01\dot{3}$, giving the result in decimals.

4. When the rupee is worth 1*s.* $7\frac{3}{4}$*d.*, what is the nearest sum of Indian money equivalent to £79. 3*s.* $7\frac{3}{4}$*d.*?

5. A tea-merchant has a rectangular space for storing tea. It is $15\frac{3}{4}$ ft. long, $10\frac{1}{2}$ ft. broad and $9\frac{3}{8}$ ft. high. He wishes to fill this space with packets of a cubical shape all of the same size. What is the largest size of such cubical packets that can be made to fill it exactly, and what would be the number of such packets?

6. *A* starts in business at the beginning of the year with R3,000. On March 1st, he takes a partner *B* with R4,000. And on June 1st, he receives another partner *C* with R5,000. The profits at the end of the year amount to R1,480. What share of the profits should each partner receive? And what is the rate per cent. per month of the profits on the capital invested?

7. What sum of money must I invest at 4 per cent. compound interest so that I may gain R390. 3*a*. $2\frac{3}{4}$*p*. in three years?

8. A tradesman has been accustomed to give his customers three months' credit, but wishes to introduce the ready money system into his business. For how much ready cash should he sell an article that he has hitherto sold for £8. 2*s*., the rate of interest charged being 5 per cent. per annum?

9. What rate per cent. will be received for money invested in $3\frac{1}{2}$ per cent. stock at 84?

10. Find the cost of building the walls of a rectangular room, 20 ft. long, 16 ft. broad, and 10 ft. high, with a door 7 ft. by 4 ft. and a window 5 ft. by 3 ft., at $2\frac{1}{2}$*a*. per cubic foot, the walls being 2 ft. thick.

1885.

1. Explain how the value of a fraction is not altered when its numerator and denominator are multiplied by the same number.

Simplify $\left(\dfrac{\frac{4}{11}\text{ of }1\frac{4}{7}-\frac{3}{8}+\frac{9}{7}}{\frac{5}{7}\text{ of }1\frac{5}{6}+1\frac{1}{7}}\right)\times 4\frac{8}{10}-\frac{5}{6}\text{ of }\frac{4}{5}$.

2. If the rupee is worth 1*s*. $6\frac{3}{4}$*d*., express R6. 5*a*. 4*p*. as a fraction of £1; and find the least number of rupees equal in value to an integral number of pounds.

3. State the rule for converting recurring decimals into vulgar fractions; and find the value of $\dot{0}\cdot0\dot{3}$ of 2·75 of £3. 2*s*. 6*d*. + $0\cdot\dot{2}8571\dot{4}$ of 1·3 of £7. 5*s*. 10*d*. − $0\cdot5\dot{9}2\dot{5}$ of £2. 16*s*. 3*d*.

4. Find by any method the value of 5 cwt. 2 qr. 21 lb. of goods at £3. 7*s*. 6*d*. per cwt.

5. The carriage of $17\frac{1}{2}$ cwt. for 52 miles on a certain railway is 8*s*. 4*d*.; find what will be the cost of carrying $4\frac{2}{7}$ cwt. for 300 miles on a railway on which the rate per mile is 9 per cent. lower.

6. A landlord pays 1 per cent. for collecting his rents and a tax of 7 pies in the rupee on what he receives after paying the collector. He has a clear rental of R1,831. 8*a*. Find his gross rental.

7. A grocer mixes four kinds of tea which cost him 5*s*., 4*s*., 3*s*., 2*s*. per lb. respectively in the proportions of 2, 3, 4, 7 respectively. Find at what rate he must sell the mixture so as to gain 25 per cent. on the whole.

8. Define the terms *interest*, *discount*, and find in what time £533. 6*s.* 8*d.* will amount to £672 at $6\frac{1}{2}$ per cent. per annum simple interest.

9. A person invests £4800 in 4 per cent. stock at 95, and after a year sells out at $92\frac{1}{2}$ and invests the proceeds together with the interest for the year in stock at $96\frac{1}{4}$. How much stock does he then purchase?

10 Find to four places of decimals the square root of [illegible]; and calculate the cost of surrounding with a fence a square field of $22\frac{1}{2}$ acres at 3*d.* per yard.

11. The population of a country increases at the rate of 7 per cent. every 10 years. What was the population 20 years ago of a country whose present population is 4,007,150?

1886.

(*N. B.*—Answers in money must be stated in £. *s.* *d.* or in R. *a.* *p.* as the case may be, and not as fractions of £1. or of R1.)

1. State and explain the rule for the multiplication of vulgar fractions.

Simplify $\dfrac{\frac{5}{9}(1\frac{2}{3}-\frac{1}{8}\text{ of }1\frac{4}{9})+\frac{1}{17}}{\frac{7}{1}\times 1\frac{4}{7}\div 1\frac{1}{2}-\frac{1}{2}\frac{1}{5}}\times\dfrac{\frac{2}{4}+\frac{3}{8}}{\frac{3}{4}-\frac{2}{8}}-20.$

2. Express £66. 14*s.* $5\frac{1}{4}$*d.* as the decimal of R1,000, the rupee being worth 1*s.* $4\frac{1}{2}$*d.*

3. Distinguish between pure and mixed recurring decimals.

Find the value of $0{\cdot}94\dot{5}$ of £2. 3*s.* $6\frac{1}{2}$*d.* + $0{\cdot}37\dot{2}5\dot{9}$ of £1 8*s.* $1\frac{1}{2}$*d.*

4 Find by any method the rent of 156 ac. 3 r. 24 p. 11 sq. yd. at R25. 3*a.* 4*p.* per acre.

5. A clock which gains 3 m. 56 s. in 24 hr. was set correctly at noon on the 1st of January 1884. Find to the nearest minute the next date at which it indicated correct time.

6. Twenty men are employed to make a tank 40 ft. long, 20 ft. broad, and 6 ft. deep. They work for 30 days and have just completed one-third of the work, when it is resolved to increase the length of the tank by 10 ft., the breadth by 4 ft. and the depth by 2 ft. How many additional men must be employed in order that the work may be completed in 30 days more?

7. The difference between the simple and compound interest on a sum of money for 3 years at 5 per cent. is £7. 12*s.* 6*d.* Find the sum.

8. The capital of a certain railway is £1000000 in 20000 shares of £50 each, fully paid up. The gross annual receipts are 105000 of which 48 per cent. is absorbed in working expenses, £4500 goes to the reserve fund, and the remainder to pay dividend. Find what annual income a person will obtain from the investment of £4500 in the undertaking, the shares being at £62. 10*s.*

9. Ice is manufactured for 6 pies a pound. Two thirds of the quantity made is kept for sale at the factory and the remainder is sent to branch shops. If the average loss from melting of the former be $12\frac{1}{2}$ per cent. and that of the latter be 25 per cent., find the gain on every ton made.

10. The average width and depth of a river at its mouth are 240 yd.

and 6 feet respectively, the average rate of flow is 3 miles per hour, and the amount of sediment per cubic foot of water discharged is $1\frac{1}{2}$ cubic inches. Find the amount of sediment deposited annually; and the depth of the deposit, supposing it spread uniformly (*i. e.*, to the same depth throughout) over an area of 146 square miles.

1888.

(*N. B.* (1) Answers in money must be stated in £. *s. d.* or in R. *a. p.* as the case may be and not as fractions of the £1 or R1. (2) Except in question 1, the process by which each result has been obtained must be given in full).

1. Add together (without copying out) the following sums, and write down the results :—

(1)	£.	*s.*	*d.*	(2)	R.	*a.*	*p.*
	2065	19	$0\frac{1}{2}$		20581	15	4
	149	0	7		3690	4	11
	6695	4	$3\frac{3}{4}$		28	11	7
	12964	13	$11\frac{1}{2}$		308	8	8
	24	8	$9\frac{1}{4}$		19075	0	5
	1549	17	$5\frac{3}{4}$		9	14	6
	707	3	10		207	9	10
	19208	10	$0\frac{1}{2}$		53968	13	1
	6	15	$9\frac{3}{4}$		6072	8	7
	358	1	$10\frac{1}{2}$		90	1	9
	68877	4	$11\frac{1}{4}$		7782	12	3
	4059	17	$5\frac{3}{4}$		30259	15	10

2. Simplify $\dfrac{6\frac{3}{5} - 4\frac{1}{8}}{5\frac{1}{3} - 4\frac{5}{8}} - \dfrac{2\frac{2}{35} \div 1\frac{11}{25} + 1\frac{1}{4} - \frac{9}{14} \text{ of } 3\frac{1}{4}}{\frac{3}{2} \times 3\frac{2}{7} - 5\frac{3}{5} \div 3\frac{4}{15}} \times 13\frac{1}{2}$.

3. Find the value of $1\frac{3}{17}$ of $\cdot 012\dot{3}6$ of R5. 11*a.* 8*p.*; and taking the rupee as worth 1*s.* $4\frac{1}{2}$*d.*, express the result as the decimal of one shilling.

4. Find by any method the value of 9 tons. 17 cwt. 3 qr. 25 lb. of coffee at £72. 18*s.* 4*d.* per ton.

5. When iron is at £3. 7*s.* 6*d.* a ton, the cost of laying a railway 10 miles 2 fur. 20 po. in length with rails weighing 270 lb. each is R67,500. Find the cost of laying a railway 25 miles 220 yd. long with rails of the same length weighing 500 lb. each, when iron is at £3. 14*s.* 3*d.* a ton.

6. Find the present value of £482. 6*s.* $10\frac{1}{2}$*d.* due 3 years hence at 5 per cent. compound interest.

7. When exchange is at the rate of 1*s.* $4\frac{1}{2}$*d.* per rupee, a person in Madras orders from a bookseller in England a parcel of books, the published price of which is £5. The bookseller allows discount at the rate of 25 per cent. on the published price, but includes in his bill a charge of 13*s.* for packing, freight, &c. When the books arrive in India, a further sum of R2 8*a.* has to be paid on account of landing charges and cost of delivery. If the books can be obtained from a bookseller in Madras at the rate of $9\frac{1}{2}$ annas per shilling of the published price, find how much the person loses by ordering from England.

8. A person holds forty R500 shares in a concern which pays dividend at the rate of 6 per cent. per annum. When the shares are at R675, he sells out and invests half the proceeds in 4 per cent. stock at 90. With the other half he buys a house, for which he receives an annual rental of R1,440, subject to a deduction of 3*a*. 9*p*. per rupee for repairs and taxes. Find the alteration in his annual income.

9. In a certain year a country produces 50,000,000, bushels of wheat. Of this quantity 40 per cent. is available for export at R3. 2*a*. per bushel. In the following year the acreage under wheat has increased 20 per cent. but the yield per acre is only seven-eighths of what it was in the previous year, while the quantity required in the country has increased 5 per cent. If at the same time the export price has fallen to R3 per bushel, find the increase in the value of the wheat available for export.

10. The population of a country is 33,264,000, and there are 99 males to 101 females. 2 out of every 11 boys and 1 out of every 33 girls of school-age are under instruction. If the boys of school-age form one-seventh of the male population, and the girls of school-age form one-seventh of the female population. Find the total number of pupils under instruction.

1889.

[*N. B.*—(1) Answers in money must be stated in £. *s*. *d*. or in R. *a*. *p*. as the case may be, and not as fractions of £1 or of R1. (2) Except in the case of question 1., the process by which each result has been obtained must be given in full.)

1. Add together (without copying out) the following sums and write down the results :—

£.	*s*.	*d*.	R.	*a*.	*p*.
172	19	$7\frac{3}{4}$	12851	3	4
4372	13	$6\frac{1}{2}$	208	13	10
267	11	9	3796	10	7
29	3	$0\frac{3}{4}$	82	1	9
7901	9	$11\frac{1}{4}$	53028	9	5
99	7	$8\frac{1}{2}$	203	15	11
5	3	$10\frac{1}{4}$	8888	9	1
149	0	7	535	15	8
6	15	$9\frac{1}{2}$	26	0	10
1000	6	$5\frac{3}{4}$	24370	12	2

2. Simplify $\dfrac{\frac{1}{3}+\frac{1}{7}\div(\frac{1}{7}-\frac{1}{9})}{(\frac{1}{3}+\frac{1}{7})\div\frac{1}{7}-\frac{1}{9}}\div\dfrac{1\frac{7}{8}+\frac{3}{28}}{\frac{7}{12}-\frac{1}{7}}-\dfrac{\frac{1}{2}\text{ of }\frac{1}{3}}{\frac{1}{2}\div\frac{1}{3}}$.

3. Multiply $41{\cdot}36\dot{5}1\dot{4}$ by $\cdot 001\dot{9}$, expressing the result as a decimal ; and find the value of $\cdot 347\dot{2}$ of £1. 4*s*. – $\cdot 03\dot{2}8\dot{8}$ of £2. 6*s*. 3*d*.

4. Find by any method the cost of 79 ca. 17 m. 5 v. 25 pal. of salt at R21. 10*a*. 8*p*. per candy.

5. The cost of rice for a family of 2 adults and 3 children from January 1st, 1889, to December 11th, 1889, both days inclusive, during which time rice was selling at 15·4 seers per rupee, was R70. 7*a*. What will be the

cost of rice for a family of 3 adults and 5 children from December 19th, 1889, to May 11th, 1890, both days inclusive, assuming that the price of rice will be 14·7 seers per rupee, and assuming also that the quantity required per day by each adult is the same in both cases, and that in both cases the quantity required by a child is two-fifths of the quantity required by an adult ?

6. On what sum due 1 year 4 months hence does the true discount amount to £100. 18*s.* 9*d.*, simple interest being reckoned at $4\frac{3}{4}$ per cent. per annum ?

7. How much 3 per cent. stock must a person sell when the selling price is 91. in order that by investing the proceeds in the $4\frac{1}{2}$ per cents. at $113\frac{3}{4}$ he may derive from the investment an annual income of R9817. 8*a.*, after paying income-tax at the rate of 5 pies per rupee ?

8. *A* and *B* can do a piece of work in 10 days, *B* and *C* in 15 days, and *C* and *A* in 20 days. They all work at it for 6 days ; then *A* leaves, and *B* and *C* go on together for 4 days more. If *B* then leaves, how long will *C* take to complete the work ?

9. In a certain year the total amount received by a railway company for the carriage of passengers was R2751000. Of this sum 6 per cent. was contributed by first class passengers, 5 per cent. by second class, and the remainder by third class The fares were 18, 6, and $1\frac{3}{4}$ pies per mile for first, second, and third class passengers respectively. Assuming that the average distance travelled by each third class passenger was 36 miles, and the average distance travelled by each passenger of the other classes was 160 miles, find the total number of passengers carried during the year.

10. The length of a rectangular field is twice its breadth. If the rent of the field at £3. 7*s.* 6*d.* an acre is £151. 17*s.* 6*d.*, find the cost of surrounding it with a fence at $4\frac{1}{4}$*d.* per yard.

11. Extract the cube root of 9 to five decimal places.

1890.

1. Reduce 2149908480 sq. inches to acres, etc. If this is the area of a rectangle the length of which is 5 m. 7 fur. 5p. 1 ft. 6 in., find its breadth.

2. Simplify $\frac{1835}{2202} + \frac{5468}{12303} + \frac{147}{441} - 3\frac{1}{7}$ of $\frac{6·25}{5·5}$ of $\frac{·04}{1·\dot{2}8571\dot{4}}$.

3. Find the value of 237 candies 17 maunds 6 viss at R4100. 1*a.* 4*p.* per candy.

4. 300 coolies are set to build a tank-bund. In 14 weeks they have done $\frac{7}{16}$ of the work when rain stops the work for 4 weeks and washes away $\frac{3}{7}$ of what they have done. At the end of that time the work is resumed with only 250 coolies. In what time from the commencement will the work be finished ?

5. Find the amount of R5859375 for 3 years at $4\frac{1}{2}$ per cent. per annum, reckoning compound interest.

6. Explain the difference between discount and interest. If the discount on £2830. 15*s.* $7\frac{1}{2}$*d.* be equal to the simple interest on £2784. 7*s.* 6*d.*

for the same time, find the time, the rate of interest being 5 per cent. per annum.

7. A person invests £34539 in the 3 per cents. at 87. After receiving one year's dividend he sells out at 89. He then invests the whole in Railway stock, paying 5 per cent. at 115. What will the difference in his income be?

8. A cistern 10 ft. 6 in. long by 7 ft. 6 in. wide, by 3 ft. 4 in. high is lined inside with lead, 7 lb. of which cover a square foot. Find the weight of the lead and its cost at 53*s.* 4*d.* per cwt.

9 A cask contains 16 gallons of spirit. Two gallons are drawn off and the cask filled up with water Two gallons are again drawn off and the cask filled up as before. This is done a third time. Compare the quantities of spirit and water remaining in the cask.

10. Find the square root of 379749833·583241.

1891.

Add together

£.	s.	d.
104	14	$6\frac{1}{4}$
39	11	$4\frac{1}{2}$
166	15	$0\frac{3}{4}$
27	0	$5\frac{1}{3}$
1103	19	$3\frac{1}{2}$
1002	15	$4\frac{1}{4}$
6	3	$11\frac{1}{2}$
32234	15	$7\frac{1}{4}$
8192	12	6
8	4	10
13	7	$0\frac{1}{2}$

2. Subtract 13 times R17. 6*a.* 11*p.* from 17 times R13. 6*a.* 11*p.*

3. R330. 3*a.* 7*p.* are to be divided among 193 persons, two of whom receive R2 each, and ten R3 each. The others receive equal shares. Find the value of each share.

4. Find the value of $\dfrac{\frac{1}{3}+\frac{1}{4}+\frac{1}{5}+\frac{1}{6}}{\frac{1}{3}-\frac{1}{4}+\frac{1}{5}-\frac{1}{6}} \times 3\frac{1}{2} \div \dfrac{\frac{1}{15}+\frac{1}{20}+\frac{1}{24}}{\frac{1}{2}-\frac{1}{3}+\frac{1}{4}-\frac{1}{5}-\frac{1}{6}}$; and simplify (without reduction to vulgar fractions if you can)

$$2·03 + 1·3\dot{4}\dot{5} + 27·34 + 16·\dot{2}31\dot{7}.$$

5. How long will it take to walk round a square field 14 acres 1 rood 24 poles in extent at the rate of 3 miles an hour?

6. Find the cost of white-washing a room $22\frac{1}{2}$ ft. by 12 ft. and 11 ft. high, at one anna per square yard, making allowance for four windows each 4 ft. × $2\frac{1}{2}$ ft. and two doors each $8\frac{1}{2}$ ft. × 4 ft. Find also the cost of a carpet for the same room with 3 ft. border all round the carpet, costing R4 per square yard and the border R6 per square yard.

7. Find the compound interest on £3143. 6*s.* 8*d.* for 3 years at 3 per cent. per annum.

8. A cistern can be filled by three pipes in 30, 40, and 60 minutes

respectively, and emptied by an escape pipe in half an hour. The three taps are turned on at noon, but the escape pipe is at the same time accidentally left open and not closed for a quarter of an hour. At what time will the cistern be full?

9. I purchase 16 lb. of tea at 1*s*. 7*d* per lb., 14 at 2*s*. 2*d*. and 17 at 1*s*. 8*d*. Seven pounds of the mixture becoming spoiled have to be sold at a low price, but by selling half the remainder at 2*s*. 4*d*. per lb. and the other half at 2*s*. 7½*d*., I eventually make a profit of 25 per cent. on the original outlay. At what price per pound was the spoiled tea sold?

10. A person invests a sum of money in the 4 per cents. at 102. When they have risen to 104, he transfers R6000 stock to another investment paying 5 per cent. of which the shares are at 120. When the 4 per cents. fall to par, he transfers the remainder to the 5 per cent, which are still at the same price and now finds his income R25 more per annum than it was at first. What was the sum originally invested?

1892.

(*N. B.* (1) Answers in money must be stated in £. *s*. *d*. or in R. *a*. *p*. as the case may be, and not as fractions of £1. or R1; (2) Except in the case of question 1., the process by which each result has been obtained must be given in full.)

1. Add together (without copying out) the following sums, and write down the results:

(1)	tons.	cwt.	qr.	lb.
	3124	17	2	27
	65097	3	1	19
	385	14	3	6
	20039	10	0	13
	1470	11	2	19
	38965	6	1	7
	13	7	3	21
	5082	8	3	14
	97654	19	1	0
	38046	16	0	25
	909	3	2	11
	41203	15	3	26
(2)	ca.	md.	v.	pal.
	19937	19	7	39
	2016	13	3	25
	26	10	2	19
	4309	17	6	35
	18197	9	4	12
	98006	14	0	26
	1779	0	5	17
	909	7	3	31
	1472	18	7	9
	99	15	2	37
	3201	7	0	21
	69547	12	3	16

2. Simplify $\dfrac{\frac{5}{7}\text{ of }1\frac{3}{8}-\frac{5}{8}\text{ of }\frac{6}{7}}{1-\frac{1}{7}\times(\frac{5}{12}+\frac{1}{3})}\times\dfrac{\frac{1}{3}+\frac{1}{7}\div(\frac{1}{7}-\frac{1}{9})}{(\frac{1}{3}+\frac{1}{7})\div\frac{1}{7}-\frac{1}{9}}$

3. Find the value of $\cdot041\dot{6}$ of £33. 7*s.* 6*d.* − $\cdot034\dot{5}$ of £32. 13*s.* 1½*d.*; and express R371. 2*a.* 6*p.* as the decimal of a lakh of rupees.

4. Find by any method the cost of making a road 37 m. 6 f. 31 p. 3 yd. long at R1785. 3*a.* 4*p.* per mile.

5. Find the present value of £482. 6*s.* 10½*d.* due three years hence at 5 per cent. per annum compound interest.

6. Extract the square root of 13·697142031225 to six places of decimals.

7. The annual rainfall of a district is 49·7 inches. Assuming that the fall is distributed uniformly over the district, and that a cubic foot of water weighs 62·5 lb., find the weight in tons of the rain that falls throughout the year on a square mile.

8. When exchange is 1*s.* 2⅝*d.* per rupee, a Madras bookseller sends to a London publisher a bill for £104 in payment of books ordered. Freight and landing charges amount to R37. 8*a.* The publisher allows the bookseller discount at the rate of 35 per cent. on the published price, and the latter sells the books at the rate of 10½ annas per shilling of the published price. Find how much he gains on the transaction.

9. In the year 1891, the cost of rice for a family of 2 adults and 4 children was R86. 7*a.* 9*p.* In that year rice sold at 11·2 seers per rupee, and each child received two-fifths of the amount given to an adult. Assuming that in 1893 the price of rice will be 13·5 seers per rupee, what will be the cost of rice, for the same family from January 5 to August 11 both days inclusive, if the allowance of each adult be increased by one-fourth and the allowance of each child be three-sevenths of that of an adult?

10. The capital of a railway company amounts to R18,90,00,000 of which one-fourth is 5 per cent. preference stock and one third 4½ per cent. preference stock. In a certain year the receipts are R1,81,50,000, and the working expenses amount to 55 per cent. of the receipts. Of the net receipts R540000 are added to the reserve fund, and the remainder, after paying dividend on the preference stock, is divided among the ordinary shareholders. What rate of interest will they receive?

11. In the ten years from 1871 to 1881 the population of a country increased at the rate of 9·5 per cent., and in the ten years from 1881 to 1891 the rate of increase was 10·5 per cent. If the population in 1891 was 31,023,759, find what it was in 1871.

1894.

[*N. B.*—(1) Answers in money must be stated in £. *s.* *d.* or in R. *a.* *p.* as the case may be, and not as fractions of £1 or of R1.

(2) Except in the case of Question 1. the process by which each result has been obtained must be given in full.]

1. Add together (without copying out) the following sums, and write down the results.

(1)

R.	a.	p.
166595	13	5
5598	6	11
201550	4	11
157726	4	9
24066	2	6
8339	15	10
190131	7	3
483	11	11
403003	11	8
972177	12	7

(2)

m.	fur.	po.	yd.	ft.	in.
26	7	25	4	2	9
3	0	6	3	2	5
209	4	37	2	1	6
43	6	0	0	2	0
95	0	29	1	1	7
1	5	19	4	0	8
10	3	9	3	2	11
179	6	39	3	0	4
83	1	21	2	1	5
101	7	13	4	2	9

Simplify [illegible]

3. Find the value of 2·04752 of £2. 2s. 1d. – 1·734375 of £2. 6s. 8d.

4. Find by any method the value of 59 ca. 14 m. 7 v. 27 pal. of salt at R26. 10a. 8p. per candy.

5. In a certain year the produce of a tea-estate was sold in London at an average rate of $9\frac{1}{2}d.$ per lb., and the amount realised was remitted at an average rate of exchange of 1s. $2\frac{1}{4}d.$ per rupee. In the following year the average price realised was only $8\frac{3}{4}d.$ per lb., but the quantity sold exceeded by $12\frac{1}{2}$ per cent. the quantity sold in the previous year and the average rate of exchange at which remittances were made fell to 1s. $1\frac{1}{2}d.$ If in this year the total amount realised from sales in London was R105000, find how much was realised in the previous year.

6. A sum of money was invested for four years, interest payable annually. The rate of interest was 5 per cent. per annum for the first two years and 4 per cent. per annum for the last two; and the amount at the end of four years was £1,164. 10s. $3\frac{3}{4}d.$ What was the sum invested?

7. Ice is manufactured for $2\frac{1}{2}$ pies per lb. and sold at 6 pies per lb. Of the total quantity made one half is kept for sale at the factory, and the remainder sent to branch shops. The loss from melting is $12\frac{1}{2}$ per cent. in the case of the former and 25 per cent. in the latter; and the agents at the branch shops receive commission at the rate of 15 per cent. on the price of every pound sold by them. Find the profit on every ton of ice manufactured.

8. Two persons, *A* and *B*, set out together on a journey. They walked at the rate of 3 miles an hour; and after they had proceeded for three quarters of a mile, *B* returned, walking at the same rate, to the place of starting. Here he was detained three quarters of an hour. Setting out again he overtook *A*, who had been walking all the time, at the end of $2\frac{1}{2}$ hours from the second time of starting. At what rate did he walk?

9. A person sold 25 Bank of Madras shares and invested the proceeds in the Government $3\frac{1}{2}$ per cents. when they were at $3\frac{1}{4}$ premium. If his net annual income from the investment, after paying income-tax at the rate of 5p. in the rupee, be R876. 9a., find the price at which he sold each of his bank shares.

10. In the year 1891 the population of a country was 35640000 and

there were 1025 females to every 1000 males. Of the total population 7·5 per cent. could read and write, but of the females only 1 per cent. could do so. Find what percentage of males could read and write.

11. Extract the square root of 81·13183159704101 to seven places of decimals.

III. UNIVERSITY OF BOMBAY. ENTRANCE PAPERS.

1859.

1. What is the value of a chest of tea weighing 2 cwt. 1 qr. 19 lb. at R2 per lb. ?

2. What is the price of a silver cup weighing 1 lb. 7 oz. 14 dwt. at R2. 8*a*. per oz. for the metal, and $7\frac{1}{2}$*a*. per oz. for the workmanship ?

3. Define a fraction ; and explain the effect on the value of a fraction of adding the same number to the numerator and the denominator. Why do you bring fractions to the same common denominator before adding them together ?

Add together $\frac{5}{8}$, $7\frac{5}{8}$ and $\frac{1}{8}$ of $\frac{3}{4}$.

4. Divide $\dfrac{48\frac{4}{7}}{1085\frac{7}{10}}$ by $\dfrac{7\frac{3}{11}}{174\frac{8}{17}}$.

5. Express $\frac{5}{6}$ of $1\frac{1}{4}$ rupees as the fraction of $\frac{1}{2}$ rupee.

6. A general after sending $\frac{1}{4}$ of his men to forage in one direction, and $\frac{1}{3}$ of them in another, had 700 remaining. How many did he command ?

7. If 72 men can do a certain piece of work in 63 days, how long will it take 42 men to do the same ?

8. Define a decimal and reduce 14 minutes to the decimal of a day.

9. Extract the square roots of 2·5, ·0625 and 1020304030201.

10. The top of a tank is a rectangle, whose sides are 9 feet and 15 feet ; it is of the same horizontal section throughout its depth. What must be its depth in order that it may contain 12960 gallons of water, one gallon containing 277·274 cubic inches ?

11. Find the interest on R100,000 for four years, at 3 per cent. compound interest.

12. The sum of R6,000 is to be divided among 24 men, 36 women and 72 children, so that the shares of 2 men shall be equal to those of 3 women, and each woman's share to the shares of 2 children. What will be the share of each ?

1860.

1. State the distinction between Direct Proportion and Inverse Proportion ; and find how much land at 27*s*. per acre should be given in exchange for 480 acres at 36*s*. per acre.

2. Find the greatest number which is contained exactly in 378, 462

and 693 ; and find the least fraction which, added to the sum of $\frac{3}{4}$. $\frac{1}{8}$ and $\frac{22}{12}$, shall make the result an integer.

3. In multiplication of decimals how do you determine the position of the decimal point in the product ? State the reason of the rule.

4. Simplify (·18 + ·009) ÷ ·016 ; and reduce £1. 13*s.* 6$\frac{3}{4}$*d.* to the decimal of £3.

5. Divide ·00432 by 240 and 43200 by ·024 ; and extract the square root of ·0002359296.

6. Of what sum of money does the half exceed the fifth part by £216 ?

7. *A* buys 200 shares in the G. I. P. Railway at R1,000 each and when they are paying 2 per cent., sells them at R460 each, and invest the proceeds in the 4$\frac{1}{2}$ per cent. Government loan at 92. Find the effect on his income.

8. Find the value of 537 articles at R3. 7*a.* 2$\frac{1}{2}$*p.* each (by Practice).

9. What will 3650 rupees amount to in 4 years and 2 months at R3. 6*a.* 8*p.* per cent. per annum at simple interest ? In what time would a sum of money double itself at the above rate ?

10. If a cubic foot of marble weigh 2·716 times as much as a cubic foot of water, find the weight of a block of marble 9 ft. 6 in. long, 2 ft. 3 in. broad and 2 ft. thick, supposing a cubic foot of water to weigh 1000 oz.

11. The surface of a cube is 346·56 square feet ; what is the length of an edge ?

1861.

1. Express in words 11603700160, and write in Roman numerals 4960 and 10684.

2. Multiply R1875. 13*a.* 8*p.* by 27, and find how many times R1. 0*a.* 4$\frac{1}{2}$*p.* are contained in R2. 12*a.* 3$\frac{1}{2}$*p.*

3. If 4 candies 2 maunds 7 seers of sugar cost R36. 3*a.*, what is the price of 3 maunds 14 seers ?

4. A bankrupt pays 17*s.* 6*d.* in the pound ; how much does he pay in R267. 6*a.* 8*p.* ? (Practice).

5. Reduce $\dfrac{3\frac{1}{2} - 2\frac{1}{4}}{\frac{1}{2} \text{ of } (\frac{1}{3} + \frac{1}{7})} \div 15\frac{3}{4}$ to its simplest form.

Find a sum of money which shall be the same fraction of R61. 9*a.* [illegible]*p.* that 2 cwt. 2 qr. 10 lb. is of 36 cwt. 1 qr.

6. Reduce 13*a.* 6$\frac{3}{4}$*p.* to the decimal of (1) R1, (2) R1000 and (3) R·00001.

Divide 1255 by 1·004 and hence deduce the quotient of 12·55 by 1004 and ·012550 by 1004000.

7. How is it that the value of a decimal fraction is not altered by adding on the right hand any number of ciphers ?

8. What sum must *A* bequeath to *B* so that *B* may receive ₨10,000 clear, after deducting a legacy duty of 10 per cent. ?

9. Find the simple and compound interest of £625 in 2 years at 4 per cent.

1862.

1. What is the fundamental principle in our system of Arithmetic? Write the number three millions four hundred and fifty-two thousand one hundred sixty-seven in an algebraical form, using x to denote ten.

How would the Romans have written the numbers which are expressed in our notation 1918, 1231, 1262, 1862 ?

2. Divide 31 by ·124869 and ·124869 by 31. Give the *reason* of the rule for placing the decimal point in the quotient.

3. The Hindu year consists of 365 days 6 hours $12\frac{1}{2}$ minutes, the Mahomedan of 354 days 8 hours 48 minutes. After what length of time would the accumulated difference between them amount to the tropical year of 365 days 5 hours 48 minutes 49·7 seconds ?

4. A bag contains a certain number of rupees, half as many again two-anna pieces, and 4 times as many pysas, and the value of the whole is ₨300 ; find how many rupees, how many two-anna pieces and how many pysas are there ?

5. How many times does $(\frac{2}{5}+\frac{3}{8}-\frac{1}{10})$ contain $(\frac{2}{7}+\frac{1}{8}-\frac{1}{12})$?

6. What decimal of 1 bushel 1 pint is $\frac{2}{3}$rds of 3 gallons 2 pints ?

7. Divide accurately $\cdot 0\dot{3}2\dot{4}$ by $\cdot 3\dot{6}$ and extract the square root of the quotient to four figures.

8. A creditor receives upon a debt of ₨3,270 a dividend of 9 annas 2 pies in the rupee, and afterwards he receives a further dividend upon the deficiency of 3 annas 4 pies in the rupee ; how much does he receive on the whole ?

9. Extract the cube root of $\frac{4}{7}$ to three places of decimals.

10. Find the true present value of two sums of ₨100 payable at the end of one year and two years respectively, money making $7\frac{1}{2}$ per cent. per annum.

11. If mangoes be bought at the rate of seven for an anna, how must they be sold to gain 33 per cent. ?

12. Four French feet are equal to 1·3 metres, and 15 French feet are equal to 16 English feet ; how many metres are 27 English feet equivalent to ?

1863.

1. Explain the principle of the Decimal System of Numeration. Write down in words the number 4010010. What number expressed in the Decimal System, is identical with the number 4321, in which the base of the system of numeration is 12 ?

2. Divide ₨6148. 5*a*. 4*p*. by 136.

3. *A* barters some sugar, with *B* for flour which is worth 2*s*. 3*d*. per stone, but uses a false stone-weight of $13\frac{1}{2}$ lb.; what value should *B* set upon his flour, that the exchange may be fair?

4. An annual tax of R2,255 is laid upon a district containing four villages—*A*, *B*, *C*, *D*,—and the rate to be paid by each of the villages *A*, *B*, and *C*, is to the rate to be paid by *D*, as 3 to 2: what are the annual payments due from the villages?

5. Explain the following terms—*an improper fraction*, *a compound fraction*, *a mixed number*. Add together $\frac{1}{3}$ of [illegible] of a year, [illegible] of [illegible] of a day and [illegible] of $\frac{3}{8}$ of $19\frac{1}{2}$ hours.

6. Divide ·00333822 by ·1357. Reduce 18*s*. $9\frac{3}{4}$*d*. to the decimal of one pound.

7. The area of the entire surface of a pond is 9 acres 2 roods 15 poles; find to 3 places of decimals, the number of yards in the side of a square piece of ground of equal area.

8. A man sells a horse for R246 and loses $26\frac{2}{3}$ per cent. on what the horse cost him: what was the original cost?

9. Explain the difference between *interest* and *discount*; and find the discount on £307. 6*s*. 8*d*. due 9 months hence, at 4 per cent. per annum.

10. If the carriage of 150 feet of wood, that weighs 3 stones per foot, cost R30 for 40 miles, how much will the carriage of 54 feet of wood, that weighs 8 stones per foot, cost for 25 miles?

1864.

1. Express in figures the following distances in miles of some of the planets from the sun:—

Thirty-seven millions (for Mercury).
Sixty-nine millions (for Venus).
Four hundred ninety-four millions (for Jupiter).

Write down in words the numbers signified by the following figures:—
900300804, 60660608008.

2. Find the greatest common measure of the numbers 12129 and 30081. Investigate whether the numbers 3714 and 1815 have a common measure or not.

3. Express in the scale of 8, the number seven hundred and eighty-four millions three thousand and forty-two.

4. To the sum, difference, and product of [illegible] and $\frac{9}{11}$ find a fourth proportional.

5. Find the sum, difference, product and ratio of the decimal numbers 4075·32, and 180·4215. Demonstrate the rule for pointing the quotient in the division of decimal fractions.

6. The proportions used in making English gunpowder are saltpetre 75 parts, sulphur 10 parts, and charcoal 15 parts. How many pounds weight of each material are there in 10 cwt. of gunpower?

7. Extract the square root of 115·297356.

8. *A*, *B* and *C* form a Joint stock of ₨75000, of which ₨36000 are contributed by *A*, ₨30000 by *B*, and the remainder by *C*. At the end of the year, the profit is found to be ₨16791. Required the shares of this which each is to receive, ₨800 a month being allowed as salary to *C* as acting partner.

9. Calculate the interest on 4 lakhs of rupees from the 23rd November 1864 to the 25th May 1865 at 8 per cent. per annum.

10. If 12 iron bars, each 4 feet long, 3 inches broad and 2 inches thick, weigh 576 lb., how much will 11 weigh, each 6 feet long, 4 inches broad and 3 inches thick?

1865.

1. Point and write in words, both according to the English and Indian numerations, the two numbers :—

12345676 54321.
50200400003060.

2. Subtract ₨45867. 12*a.* 6*p.* from ₨86325. 8*a.* 3*p.* How are the numbers placed in subtraction?

3. If a room is 28 feet long, 20 feet wide, 13 feet high, and the windows and doors take up half the walls, find the cost of papering at 12*a.* a square yard.

4. How many square feet are there in 578 pieces of Grey Domestics 39 inches wide and 72 yards long? and what is the price at ₨20, 14*a.* per piece?

5. Multiply $\frac{1}{2}+\frac{1}{3}+\frac{1}{4}+\frac{1}{5}+\frac{1}{6}$ by $1\frac{1}{2}\times 1\frac{1}{3}\times 1\frac{1}{4}\times 1\frac{1}{5}\times 1\frac{1}{6}$.

6. Reduce $\frac{1}{30}$, $\frac{1}{31}$, $\frac{1}{32}$ to decimals.

7. If I sell ₨500, 4 per cents. at 93, and buy $5\frac{1}{2}$ per cents. at 109, what is the change in my income?

8. Divide a lakh of rupees between *A*, *B* and *C*, in the proportion of 2, 3, 4, and the same amount between *D*, *E* and *F* in the proportion of $\frac{1}{2}$, $\frac{1}{3}$ and $\frac{1}{4}$.

9. If I sell 40 shares of ₨250 each in the Oriental Bank at 121 per cent. premium, how many shares of ₨1,000 each in the Madras Bank at 72 per cent. premium can I buy? and how much will be left?

10. A person travelled 120 miles by railway at 15 miles an hour, 120 by road at 8 miles an hour and 60 by bullock-cart at 2 miles an hour: how long did he take?

11. Find the square root of 173388·96 and the cube root of 1860·867.

1866.

1. Represent in figures :—

Ninety-nine millions, ninety-nine thousand and ninety-nine. And by the old English method of numeration, eight billions, two hundred and seven thousand and five.

Point and write in words 319680209078 and 20090060002. The first according to the Indian method and the second according to the English method of Numeration.

2. Add together $\frac{3}{4}$ of $\frac{5}{6}$ and $\frac{7}{8}+\frac{11}{12}-\frac{19}{30}$, and explain why fractions must be reduced to a common denominator for the purpose of Addition and Subtraction.

(*a*) What fraction must be divided by $\frac{2}{3}$ to give a quotient $1\frac{1}{2}$?

3. A person who has $\frac{3}{5}$ of a mine sells $\frac{3}{4}$ of his share for R1,500 ; what is the value of his share and of the whole mine ?

4. Explain why in reducing a fraction to a terminating decimal, the number of decimal places depends on the form of the denominator of the fraction and not on that of the numerator.

5. Reduce 1 cwt. 3 qr. 5 lb. to the decimal of $\frac{3}{4}$ of a ton.

6. Perform the operations indicated below :—

(i) $47{\cdot}03 - 2{\cdot}876843$. (ii) $5{\cdot}776 \times 2{\cdot}003$.

(iii) $62{\cdot}5 \div 125{\cdot}125$. (iv) $6{\cdot}25 \div {\cdot}000125$.

(v) $\sqrt{(2119{\cdot}6816)}$.

7. Define the terms :—Stocks, shares, consols. State some of the circumstances which affect their value in the market.

How much stock can be purchased by the transfer of R2000000 from the 4 per cents. at 90, to the $5\frac{1}{2}$ per cents. at 110 ; and what change would be effected in the income derived from the two investments ?

8. Find, by Practice, the price of 549 yards at 18*s*. $9\frac{1}{2}$*d*. a yd.

9. I bought cloth at 15*a*. a yard and lost 5 per cent. in selling ; what was it sold for ?

10. If a person owe R100 payable in 2 months, and R750 payable in 7 months, what is the just time for the payment of the two debts ?

1867.

1. Give a demonstrative example, illustrative of the following axiom :—

If the divisor be increased a certain number of times, the quotient is diminished in the same degree ; but if the divisor be diminished the quotient is increased.

2. Define *prime* and *composite* numbers. Resolve 54180 into prime factors.

3. Reduce $\dfrac{26\frac{2}{7} - 1\frac{1}{3}\frac{2}{1}}{\frac{4}{5}+\frac{6}{8}-\frac{1}{3}}$ to its simplest form.

4 Reduce $\frac{6}{7}$ to a circulating decimal ; and find the fraction equivalent to $1{\cdot}70\dot{1}\dot{6}$.

5. Find the product by contracted multiplication of $72{\cdot}49$ and $10{\cdot}87632$ to three places of decimals.

6. If $\frac{1}{8}$ of a maund of sugar cost R10, what will $\frac{3}{8}$ of a seer cost at the same rate ? Give answer in annas as well as in rupees.

7. Explain *direct* and *inverse* proportions.

8. 250 men are employed to work on a Railway embankment, a mile and a half long, which they are expected to finish in four weeks. But at the end of one week it is found that they have only finished 520 yards. How many more men must be engaged to finish it in the required time ?

9. What time must elapse between the time of placing R250 in the Government Savings' Bank and taking out the amount just as it goes over R300, supposing interest at 5 per cent per annum, compound interest ?

10. In a school of 250 children, 44 per cent. are learning Geography, 36 per cent. are learning Grammar, 12 per cent. cannot read, and 4 per cent. have advanced as far as Algebra. What are the actual numbers of each ?

11. Extract the square root of 6085, ·00025 and $\frac{7\cdot 98}{52\cdot 4}$.

12. What is the cost of a marble slab, 6 ft. 3 in. long, 2 ft. 8 in. broad, and 4 in. thick at R7. 8*a.* per cubic foot ?

What is the weight of the slab, one cubic foot weighing 170 lb. ?

1868.

1. How many yards of matting 2 feet 3 inches wide will be required for a square room whose side is 18 feet 9 inches ?

2. What will be the cost of a Bill of Exchange on London for £1364. 14*s.* 6*d.* at 1*s.* 10½*d.* per rupee ?

3. Reduce $\frac{\frac{2}{15}\times\frac{1}{18}}{3\cdot\frac{1}{8}}\times(\frac{1}{8}\times\frac{1}{5})$ to its simplest form.

4. What is the difference between $\cdot\dot{0}\dot{7}$ and $\cdot 0\dot{7}$?

5. If an ounce of gold be worth £$4\cdot 1895\dot{3}$, what is the value of $\cdot 0375\dot{3}$ lb. ?

6. If *A* owns ·24 of a ship, and *B* the rest, and the difference in the value of their shares is £28·76, what is the value of the whole ship ?

7. What sum must be invested in 5½ per cent. Promissory Notes to produce a monthly income of R350 ?

8. At what rate per cent. would R17,200 amount to R18,650 in 5 years ?

9. There are two schools, one containing 650 boys and the other 340 boys ; 5 per cent. of the former are generally absent and 7·5 of the latter ; what is the average attendance in each ?

10. If 8 per cent. be gained by selling 218 yards of cloth for £92. 13*s.*, at what price per yard must it be sold so as to gain 17 per cent. ?

11. If 400 men could do a piece of work in 3·4 days, how many men would do ½ of the same work in 15 days ?

12. What is the value of a beam of timber whose length is 30 feet, breadth 3½ feet, and thickness 2¼ feet, at 3*s.* 9*d.* per cubic foot ?

13. Find the cube root of ·4.

1869.

1. Find the G. C. M. of 2231 and 4656; and the L. C. M. of 4, 9, 16, 28, 42.

2. Add together $\frac{3}{8}$, $\frac{1}{11}$, $\frac{1}{21}$, $\frac{13}{61}$, $\frac{9}{124}$.

3. Find the value of :—

$$\frac{1}{3\frac{1}{5}}+\frac{2\frac{1}{4}}{9}+\frac{3\frac{3}{5}}{2}+\frac{\frac{4}{7}}{4\frac{2}{7}}.$$

4. Convert into vulgar fractions the decimals ·015625 and ·01$\dot{1}$9047$\dot{6}$ and reduce the results to their lowest terms.

5. Reduce R6. 7$\frac{3}{8}$a. to the decimal of R10.

6. Divide the sum of R328I. 12$\frac{1}{2}$a. among 4 persons in the proportion of 3, 5, 8, 9.

7. If £442 amount to £530. 8s. in 5 years, what is the rate per cent. of simple interest?

8. Find the amount of £1.000 in 6 years, at 5 per cent. compound interest.

9. If 27 men take 15 days to mow 225 acres of grass, how long will 33 men take to mow 165 acres?

10. A person has R100,000 stock in Government 4 per cents.; he sells out all his stock at 92$\frac{1}{4}$, he then re-invests the purchase money in Bank of Bombay Shares of R500 each, at R625, which pay 6 per cent. per annum; find the alteration in his income.

11. Find the square root of 3129361 and 434·02$\dot{7}$.

12. Show that the cube root of ·$\dot{0}$3$\dot{7}$ is ·$\dot{3}$.

1870.

1. Write down in figures the following :—

Six hundred and fifty-four thousand three hundred and twenty-three billions, four thousand and twenty-one millions, fifty thousand three hundred and one.

Express in words the number 1327875430029 according to the English and Hindu systems of numeration.

2. Find the value of $3\frac{3}{8}+4\frac{1}{8}+1\frac{1}{16}+3\frac{18}{625}$ both by vulgar fractions and decimals, and show that the two results coincide.

3. Divide the difference of $7\frac{3}{8}$ and $9\frac{5}{8}$ by their sum, and multiply the quotient by $\frac{5}{6}$ of $7\frac{1}{2}$.

4. If an ounce of gold be worth £4·$\dot{0}$09$\dot{9}$; what is the value of a bar of gold weighing 1·68$\dot{3}$ lb.?

5. If a family of 9 persons spend R4,800 in 8 months, how much will serve a family (living upon the same scale) of 24 persons for 16 months?

6. Three equal glasses are filled with a mixture of spirit and water; the proportion of spirit to water in each glass is as follows: in the first

glass as 2 : 3, in the second glass as 3 : 4, and in the third as 4 : 5. The contents of the three glasses are emptied into a single vessel ; what is the proportion of spirit and water in it ?

7. What are the weights of a sovereign and a shilling, the pound Troy of standard gold being coined into £46. 14*s.* 6*d.*, and the pound of silver into 66 shillings ?

8. Find the interest on £215. 12*s.* for 3 years 8 months and 10 days at $4\frac{1}{2}$ per cent. per annum.

9. A ship worth R9,000 being entirely lost, of which one-fourth belonged to *A*, one-sixth to *B*, and the remainder to *C* ; what loss will each sustain, supposing R5,400 of the ship were insured ?

10. Extract the square roots to six places of decimals of ·099 and of 3·3.

11. How much stock in the 3 per cents. must I sell to pay off a debt of £550, the price of the stock being $94\frac{1}{8}$, and commission of $\frac{1}{8}$ on £100 of stock being also taken into consideration ?

1871.

1. The distance of the sun from the earth is ninety-one millions seven hundred and seventy-six thousand miles, and light travels from the former to the latter in seven minutes and fifty eight seconds ; find the velocity of light per second.

2. Find the G. C. M. of 441441 and 844372 and the L. C. M. of 7, 11, 21, 63, 91, 99, 117, 143.

3. Define a fraction, and prove that the value of a fraction is not altered if we multiply both its numerator and denominator by the same whole number.

Bring $\left\{\left(\frac{5\frac{1}{4}-\frac{1}{3}\text{ of }2\frac{5}{8}}{\frac{3}{5}\times 4\frac{1}{3}+\frac{1}{12}}+\frac{2\frac{3}{7}}{4\frac{3}{7}}\right)\div 21\frac{23}{28}\times .3\frac{19}{200}\right\}$ cwt. to the fraction of $4\frac{1}{7}$ tons.

4. State and prove the rules for reducing terminating and circulating decimals into their equivalent vulgar fractions.

Ex. ·03125 and $\cdot\dot{7}2\dot{9}$.

Find the value of ·03125 of R2 + $\cdot\dot{7}2\dot{9}$ of R$3\frac{1}{11}$ + $\cdot\dot{7}2\dot{9}$ of R$4\frac{5}{8}$.

5. If 10 horses and 98 sheep can be kept 9 days for £37. 17*s.* 6*d.* ; what sum will keep 45 horses and 216 sheep for 40 days supposing 5 horses to eat as much as 76 sheep ?

6. If the par of exchange be two English shillings for the Indian rupee, but if an Indian bill of exchange for R540. 12*a.* be negotiated in London for £51. 10*s.* ; how much per cent. below par is the rate of exchange ?

7. Distinguish between interest and discount. The interest on a certain sum of money for three years is R825, and the discount for the same time is R645, simple interest being reckoned in both cases. Find the rate per cent. per annum and the sum.

8. A person desires to paper his room with postage stamps : the room

is 14 feet 9 inches long, 9 feet 3 inches broad and 10 feet 6 inches high; it contains two windows, each $5\frac{1}{2}$ feet by 4 feet and 3 doors each 6 feet by 3 feet; a postage stamp is $\frac{15}{16}$ inch long and $\frac{3}{4}$ inch broad. Find the number of postage stamps required to cover the room.

9. A person invests 1,250 gold mohurs in the Government five per cent. rupee stock at 105. The stock is converted subsequently to $4\frac{1}{2}$ per cents. at 95. Find the difference in his income, each gold mohur being considered equivalent to R17.

10. A certain number of persons agree to subscribe as many pies each as there are subscribers; the whole subscription being R5,797. 0*a.* 1*p.* How many subscribers were there.

1873.

1. Simplify :—

$$\frac{\frac{816}{1064463} - \frac{1}{1303}}{1 + \frac{1}{1303} \times \frac{816}{1064463}}.$$

2. Find the value of $\cdot375$ of a guinea + $\cdot5\dot{4}$ of 8*s.* 3*d.* + $\cdot0\dot{2}\dot{7}$ of £2. 15*s.* and reduce the result to the fraction of a guinea and a half.

3. A man owns $\frac{7}{25}$ of a ship and sells $\cdot\dot{3}57142\dot{8}$ of his share; what fraction of the ship does he still own?

4. If the income-tax be 6 pies in the rupee for the first half of the year and 3 per cent. in the second, what is the gross income of a gentleman whose net annual receipts amount to R1,454. 1*a.*?

5. Five men do $\cdot600\dot{6}$ of a piece of work in 2·12 hours, how long will 6 boys take to finish it, it being known that 3 men and 7 boys have done the whole piece of work in 3 hours?

6. If the difference between the simple and compound interst of a sum of money for 2 years at 5 per cent. be £5. 18*s.* $9\frac{3}{4}$*d.*, find the sum.

7. When the three per cents. were at 90, I found that by selling out and investing in the 4 per cents. at 95 I could improve my income by R243. What was the amount of my stock in the three per cents.?

8. A gardener plants an orchard with 5776 trees and arranges them so that the number of rows of trees equals the number of trees in each row. How many rows were there?

9. How many seconds will a train 184 feet in length, travelling at the rate of 21 miles an hour, take in passing another train 223 feet long, proceeding in the same direction at the rate of 16 miles an hour?

10. Find the cube root of 1879080904.

1874.

1. Simplify the fraction :—

$$\frac{\frac{1}{2} + \frac{2}{11} + \frac{7}{24} - \frac{1}{2} \text{ of } \frac{2}{11} \text{ of } \frac{7}{24}}{1 - \frac{1}{2} \text{ of } \frac{2}{11} - \frac{2}{11} \text{ of } \frac{7}{24} - \frac{7}{24} \text{ of } \frac{1}{2}}.$$

2. Divide 8·064 by $\{ \cdot84\dot{6} + \frac{22}{7} \text{ of } \cdot291\dot{6} \}$.

3. A man owns $\frac{3}{16}$ of a house, and sells $\cdot 1\dot{3}5\dot{1}$ of his share; what fraction of the house does he still own?

4. In a subscription list one-half of the subscriptions are a guinea each, one-third a half-guinea each, and the 5 shilling subscriptions which complete the list amount to £12; find the whole amount subscribed.

5. If the work done by a man, a woman and a child be in the ratio of 3, 2, 1, and there be in a factory 24 men, 20 women and 16 children, whose weekly wages amount to R204; what will be the yearly wages of 27 men, 40 women, and 15 children?

6. The debts of a bankrupt amount to £2134. 10*s.* 6*d.*, and his assets consist of property worth £916. 15*s.* 4*d.*, and an undiscounted bill of £513 due 4 months hence, simple interest being reckoned at 4 per cent. How much in the pound can he pay his creditors?

7. A merchant buys 4,000 maunds of rice, one-fifth of which he sells at a gain of five per cent., one-fourth at a gain of ten per cent., one half at a gain of twelve per cent., and the remainder at a gain of sixteen per cent. If he had sold the whole at a gain of eleven per cent., he would have made R728 more. What was the cost of the rice per maund?

8. The shares in a banking concern are R1000 each, R426. 10⅔*a.* are only paid up, and the shares are quoted in the market at R460. The dividend is R7½ per share quarterly. A gentleman holds 100 original shares. Find what interest he makes per cent.; and what he would make and how much per cent., if he sold out and invested in 4 per cent. Government stock at par.

9. *A* and *B* are the termini of a Railway 144 miles long. A fast train starts from *B* at 9 h. 0 m.: another fast train, travelling at the same rate, starts from *A* at 10 h. 0 m. A slow train starts from *B* at 10 h. 20 m.; the fast train from *A* meets the other fast train at 11 h. 30 m., and the slow train at 12 h. 32 m.; find the rates at which the trains travelled.

10. Arrange in order of magnitude:—

$$\sqrt{(50)},\ \sqrt[3]{(344)},\ \sqrt[4]{(2402)}.$$

1875.

1. Write out in words the following expressions:—

   (*a*) 8271096. (*b*) 9032804.

   (*c*) 319080259417. (*d*) 8004640.

2. What is the rule for the addition of concrete numbers? Add together 17 miles, 3 furlongs, 19 poles, 28 yards, 2 feet, 10 inches; 4 miles, 3 furlongs, 8 poles, 7 yards, 2 feet and 9 inches.

3. Explain what is meant by the following words and give exmples:—

Measure, Multiple, Greatest Common Measure, and Least Common Multiple.

4. How many acres are contained in three countries, of which the first comprises 723100 square miles, the second 12342, and the third 89704 square miles?

5. Divide $\frac{1}{2}$ of $\frac{2}{3}$ of $\frac{3}{7}$ of 42 by the sum of $2\frac{1}{6}$ and $4\frac{1}{3}$.

6. What are *continued fractions*, and when do you make use of them? Find three fractions approximating to $\frac{123}{532}$.

7. Find the product of 17·302 and ·579 to three places decimals, by the rule of contracted Multiplication.

8. What sum will discharge a debt of R7,200 due a year and a half hence at 4 per cent. per annum?

9. Find the square root of 745·29 and the cube root of 32768.

10. Divide a guinea between *A*, *B*, *C*, *D*, so that *B*'s share is $\frac{1}{3}$ more than *A*'s, *C*'s $\frac{1}{4}$ more than *B*'s and *D*'s $\frac{1}{5}$ more than *C*'s.

11. How much stock can be purchased by the transfer of R20000 stock from the 3 per cents. at 90 to $3\frac{1}{2}$ per cents. at 96: and what change will be effected in income by it?

12. Required the number of square feet there are in a piece of slate $2\frac{1}{2}$ feet $\frac{1}{3}$ in. in length, and $1\frac{1}{3}$ feet $\frac{1}{2}$ in. in width.

1877.

1. Define the arithmetical terms:—*notation*, *numeration*, *unit*, *integer*, *fraction*, *abstract*, *concrete*. Can you (1) multiply concrete numbers together? (2) divide a concrete number by a concrete number? Give examples to illustrate the nature of such operations.

2. Two men *A* and *B* start together, and when *A* has gone a mile

B has gone $\frac{3}{280}$ of $1\frac{3}{8}$ of $\dfrac{1\frac{1}{2}}{5\frac{1}{7}}$ of $\dfrac{\frac{2}{3}+\frac{1}{2}}{\frac{1}{2}-\frac{1}{3}}$ of $71\frac{3}{7}$ of $\dfrac{\dfrac{\frac{2}{5}}{1-\frac{1}{25}}+\frac{1}{3}+\frac{1}{7}}{1-\frac{1}{7}\text{ of }\left\{\dfrac{\frac{8}{5}}{1-\frac{1}{8}}+\frac{1}{3}\right\}}$ of a mile: which is in advance of the other?

3. Express the difference between $\cdot\dot{3}7\dot{8}$ of 13*s.* $10\frac{1}{2}d.$ and $\cdot 3\dot{7}\dot{8}$ of 16*s.* 6*d.* as a fraction of

$$\cdot 42\dot{6} \text{ of } \frac{3\cdot\dot{3}}{\cdot 08} \text{ of } \frac{\cdot 3}{\cdot\dot{7}3\dot{5}} \text{ of } \frac{\cdot 147\times 4\cdot\dot{4}}{11\cdot 1} \text{ of £1. 17s. 6d.}$$

4. A lb. of tea and 3 lb. of sugar cost R3, but if sugar rose 50 per cent. and tea 10 per cent. they would cost R3. 8*a.*; find the prices per lb. of tea and sugar.

5. The circumferences of the wheels of a carriage are $6\frac{3}{14}$ feet and $8\frac{1}{18}$ feet; what is the *least* distance in which both wheels will *simultaneously* complete an integral number of revolutions? How often will the lowest points of the two wheels at starting touch the ground together in 10 miles?

6. *A*, *B* and *C* rent a field for R2,878. *A* puts in 12 horses for 5 months and 45 sheep for 3 months; *B* puts in 15 oxen for 6 months and 54 sheep for two months; *C* puts in 6 horses and 48 oxen for 3 months. Now, 4 horses and 3 sheep together eat as much as 5 oxen and 1 horse, and 2 oxen eat as much as 7 sheep; how much of the rent should *A*, *B*, *C*, pay respectively?

7. What sum of money will amount to 699*l.* 13*s.* 2·4*d.* in 2 years reckoning compound interest for the first year at 4 per cent. and for the second $3\frac{1}{2}$ per cent. per annum ?

8. A person finds that if he invest a certain sum in railway shares paying £6 per share when the £100 share is at £132, he will obtain £10. 16*s.* a year more for his money than if he invest in 3 per cent. consols at 93. What sum has he to invest ?

9. Find the value of $\sqrt{(\cdot 00139876)} - \sqrt[3]{(\cdot 000030664297)}$.

10. A man near the sea-shore sees the flash of a gun fired from a vessel steaming directly towards him, and hears the report in 15″. He then walks towards the ship at the rate of 3 miles an hour, and sees a second flash 5 minutes after the first, and immediately stops ; the report follows in 10″·5. Find the rate of the ship, the velocity of sound being 1,200 feet per second.

1878.

1. Seven men find a lump of gold weighing 13 lb. $7\frac{3}{4}$ oz. Troy. What will be each man's share, supposing gold to be worth £3. 17*s.* $10\frac{1}{2}$*d.* per ounce ?

2. Simplify :—

$$1\tfrac{1}{11} - \frac{1 - \frac{7}{12}}{2 - \frac{1}{8}} + \frac{1\frac{2}{7}}{3\frac{1}{5}} - \frac{5\frac{5}{8}}{6\frac{1}{4}} \text{ of } \left\{\frac{1}{5} - \frac{\frac{1}{2} - \frac{1}{8}}{4\frac{3}{4} - 3\frac{7}{8}}\right\}.$$

3. Find the value of :—

$\cdot 3\dot{8}\dot{7}$ of £8. 16*s.* 3*d.* + $6\frac{1}{2}$ of $\frac{16}{85}$ of 7*s.* $8\frac{1}{2}$*d.* + $\frac{7}{11}$ of 1*d.*

4. What is the length of the edge of a cubical cistern which contains as much as a rectangular one whose edges are 154 ft. 11 in., 70 ft. 7 in., and 53 ft. 1 in. ?

5. In 1861 three towns had populations of 17650, 19600, 18760, respectively. In 1871 the population of the first had decreased 18 per cent., that of the second had increased 21 per cent., while the population of the third had increased by 4690 ; find the change per cent. in the population of the third town.

6. A bankrupt has goods worth R9750 ; and had they realised their full value, his creditors would have received 13*a.* in the rupee ; but $\frac{4}{5}$ths were sold at 17·5 per cent., and the remainder at 23·75 per cent., below their value. What sum did the goods fetch, and what dividend was paid ?

7. What sum will amount to £1,591. 13*s.* 2·16*d.* in 3 years at compound interest ; the interest for the first, second and third years being 3, 2 and 1 per cent. respectively ?

8. Find the true discount on £2,750 due two years hence at $4\frac{1}{2}$ per cent.

9. If 4 men earn as much in a day as 7 women, and one woman as much as 2 boys, and if 6 men, 10 women and 14 boys working together for 8 days earn £22, what will be the earnings of 8 men and 6 women working together for 10 days ?

10. A person having a certain sum of money to invest, finds that an investment in a railway stock bearing five per cent. interest at $117\frac{1}{2}$ will yield him £29 more annually than an investment in the 3 per cents. at $92\frac{1}{4}$. How much money has he to invest?

1879-80.

1. Add the following numbers:—Eighty-four thousand three hundred and one; nine hundred and thirty-three thousand; forty-seven millions six thousand three hundred; and subtract from the result two millions eighty-one thousand and eighty.

2. Explain the terms *measure*, *common measure* and *greatest common measure*, and prove that every common measure of dividend and divisor is a measure of the remainder.

3. Find the value of $\cdot45$ of £1. 3*s.* 9*d.* + $\cdot2\dot{5}\dot{7}$ of £11. 5*s.* 6*d* + $\cdot3125$ of £5.

4. Find the value of $\dfrac{\frac{7}{10}-\frac{2}{3}}{\frac{11}{12}+\frac{1}{5}} \div \dfrac{\frac{1}{8}}{9\frac{1}{2}}$ and also of $\frac{1}{2}+\frac{2}{5}-\frac{4}{15}+\frac{5}{16}$.

5. If by selling wine at R6 per gallon I lose 25 per cent., at what price must I sell it to gain 25 per cent.?

6. A person borrows £130 on the 5th of March, and pays back £132 10*s.* 6*d.* on the 18th October; find the rate of interest charged.

1880-81.

1. Simplify the following expressions:—

$$2+\cfrac{1}{5+\cfrac{1}{1\frac{1}{2}}}\ ;\quad \frac{4\cdot5\times2\cdot\dot{3}}{5\cdot341\dot{3}}\times2\frac{253}{875}$$; and add together the results.

2. Three boys agree to start together and run, until all come together again, round a circular court 15 yards in circumference. One runs at the rate of six, the second seven, and the third eight, miles an hour. In how many seconds will the race end?

3. If three soldiers or 10 coolies can dig 155 cubic feet of earth in 5 days, how many coolies must be employed to assist 7 soldiers in removing 600 cubic feet of earth so as to get it done in 4 days?

4. In what time will R2,250 amount to R2,565 at 7 per cent. per annum?

5. A merchant sells a lakh of rupees out of the four per cents. at 15 discount, and invests the proceeds while exchange is at 2*s.* 1*d.* in the three per cent. consols at 96. What income does he derive therefrom?

1881-82.

1. If the income-tax be 7*d.* in the pound in the first half of the year, and $3\frac{1}{2}$*d.* in the second, what is the net income of a gentleman whose gross annual receipts are £15[illegible] 10*s.* 6*d.*?

2. A passenger train going 41 miles an hour, and 431 feet long, overtakes a goods train on a parallel line of rails. The goods train is going 28 miles an hour, and is 713 feet long. How long does the passenger train take in passing the other?

3. Find the cost of painting the outside of a cubical box whose edge is 3·5 feet, at $1\cdot\dot{3}$ shillings per square yard.

4. A person invests R48,000 in the 4 per cents. at 80, and at the end of each year invests the dividend, which becomes due, in the same stock; supposing the funds to remain at 80 for 3 years, find his dividend at the end of the third year.

5. Define *Discount*. If the discount on R2,261 . 5 . 4 due at the end of a year and a half be R128, what is the rate of interest?

6. Find the square root of $\frac{\cdot 00125}{\cdot 18}$ and the cubic root of 423564·751.

1882-83.

1. Find the value of £·596875, and reduce 11 poles 4 yards $4\frac{1}{2}$ inches to the decimal of one mile.

2. A railway passenger counts the telegraph posts on the line as he passes them. If they are 58 yards apart and the train is going 48 miles per hour, how many will he pass per minute?

3. Three men can do as much work as five boys; the wages of three boys are equal to those of two men. A work on which 40 boys and 15 men are employed takes 8 weeks and costs £350; how long would it take if 20 boys and 20 men were employed, and how much would it cost?

4. What sum will amount to £5431. 15*s*. $11\frac{1}{4}$*d*. in 6 years at $4\frac{1}{4}$ per cent. simple interest?

5. The sides of two squares contain 77 yards 1 foot 9 inches and 7 yards 2 feet 4 inches respectively; find the side of a square whose area is equal to the sum of the areas of the two squares.

1883-84.

1. (*a*) Express in figures:—Sixteen billions, seventy-five millions, forty thousand and two.

(*b*) Simplify the expression—

$$\left(\frac{1\frac{5}{17}-\frac{6}{7}}{1\frac{2}{5}+\frac{8}{15}}\right)\div\left(\frac{\frac{9}{11}-\frac{2}{10}}{1\frac{1}{3}+\frac{9}{23}}\right).$$

(*c*) Find the value of:—3·75 of 5*s*. 6*d*. + 5·05 of £3. 1*s*. 8*d*. + $5\cdot0\dot{7}$ of 7*s*. 6*d* + $3\cdot\dot{1}3\dot{5}$ of £2. 1*s*. 3*d*.

2. At the examination of a school $\frac{1}{10}$ of the children were presented in the 6th standard, $\frac{1}{6}$ in the 5th standard, $\frac{1}{4}$ in the 4th, $\frac{1}{8}$ in the 3rd, $\frac{1}{5}$ in the 2nd, and the remainder 107 in the 1st standard; how many were presented altogether, and how many in each of the other standards?

3. In a bicycle race of two miles over a circular course of 1 furlong,

the winner in his last round overtook the second at a point in his fifteenth round. Their paces were as 159 to 149. At what distance was this point from the winning post?

4. Find the expenses of an excursion, which includes 5782 miles of railway at ¾*d.* per mile, 517 miles of carriage at 10½*d.* per mile, 57 days of hotel keep at 14*s.* 3*d.* per day, allowing 5 guineas for extras.

5. Divide 1·04 by ·000078125 and prove your result by vulgar fractions. Find the square root of 8558·3025 and the cube root of 753·571.

1884-85.

1. Reduce to a vulgar fraction ·428571. Divide 301·6 by 416. Find the value of ·475 of £1 + ·42 of £2. 17*s.* 9*d.*

2. A merchant buys 1260 maunds of corn, one-fifth of which he sells at a gain of 5 per cent., one-third at a gain of 8 per cent., and the remainder at a gain of 12 per cent. If he had sold the whole at a gain of 10 per cent., he would have obtained £22. 13*s.* more. What was the cost price per maund?

3. A room, 10 ft. 6 in. high, 22 ft. long and 14 ft. broad, is painted up to one third of the height and the remaining two-thirds papered. The painting is charged at 7½*d.* per square yard, the paper costs 5*s.* 2*d.* per square yard, and the work of papering is charged at 2*d.* per square yard. How much will the whole cost amount to?

4. A person sells out £3850 four per cent stock at 104 and invests the proceeds in another stock at 143. If the dividend on this be 5¼ per cent., what will be the change in his income?

5. What must be the rate of interest in order that the discount on £387. 7*s.* 7½*d.* payable at the end of 3 years may be £41. 10*s.* 1½*d.*?

1885-86.

1. Reduce $\frac{2\frac{1}{2} - \frac{5}{6}}{2\frac{1}{2} + \frac{5}{6}}$ of 2 guineas $+ \frac{7}{15}$ of $\frac{9 \div \cdot 1}{14 \times 3}$ of 4 crowns $- \frac{\cdot 3 \text{ of } 1\cdot 3 - \cdot 4}{1\cdot 9}$ of £1 to the decimal of 5 half-guineas and prove that $\frac{6+5}{11+7}$ is greater than $\frac{6}{11}$ and less than $\frac{5}{7}$.

2. A man contracts to perform a piece of work in 30 days and immediately employs 15 men on it; at the end of 24 days the work is only half done. How many boys should be given to assist them that the contract may be fulfilled, each boy working two-fifths as much as each man?

3. A person buys 80 tons of coal, and after selling them again at 1*s.* 6*d.* per sack finds that he has gained £4; had he sold them for 1*s.* 4*d.* per sack he would have lost £6. Find the weight of each sack and the cost price per ton.

4. A field of 7 acres is sown with wheat, barley and maize, the areas of the crops being respectively as 2½ : 3⅓ : 4⅓. If the values of an acre of each be also respectively in the same ratios, and an acre of wheat be worth £7, what is the worth of all the crops in the field?

5. If the three per cents. are at $92\frac{3}{4}$ and the four per cents. at $123\frac{1}{4}$, in which should one invest? And how much is one investing when the difference in income is a shilling?

1886-87.

1. Explain carefully the meaning of *prime number*, *factor*, *divisor*, *measure*, *multiple*.

Resolve 5005 into its prime factors.

Add together as decimals $8\cdot1\dot{3}\dot{8}$, $14\cdot6\dot{5}65\dot{1}$, $\cdot205\dot{0}8963\dot{3}$.

2. The circumference of the forewheel of a carriage is $6\frac{7}{11}$ feet and that of the hindwheel is $12\frac{5}{11}$ feet. How many feet must the carriage pass over before the wheels shall have made a complete number of revolutions?

3. A vessel is filled with a liquid, 3 parts of which are water and 5 parts syrup. How much of the mixture must be drawn off and replaced with water so that the mixture may be half water and half syrup?

4. (i) The surface of a cube is $308\cdot1\dot{6}$ square feet. Find the length of its edge.

(ii) Extract the cube root of $45\cdot\dot{6}9\dot{8}$ to four places of decimals.

5. If the price of gold be £3. 10*s*. $10\frac{1}{2}$*d*. an ounce and a cubic inch of gold weigh 10 ounces, what is the price of the gold that would be required to gild a dome whose surface is 5000 square feet, the thickness of the gold gilding being ·0002 of an inch?

6. A person invests in 4 per cent. Government paper so as to receive 4 per cent. clear when the income-tax is 5 pies in the rupee. What percentage will be received if the tax be increased to 7 pies the rupee.

1887-88.

1. Simplify $\dfrac{\cdot\dot{1}4285\dot{7}\times\cdot\dot{0}7692\dot{3}}{\cdot\dot{0}109\dot{8}\dot{9}}+\dfrac{2\cdot\dot{5}\times 11\cdot25}{6\cdot2}$.

2. If 9 lb. of rice cost as much as 4 lb. of sugar, and 14 lb. of sugar are worth as much as $1\frac{1}{2}$ lb. of tea, and 2 lb. of tea are worth 5 lb. of coffee, find the cost of 11 lb. of coffee if $2\frac{1}{2}$ lb. of rice cost $6\frac{1}{4}$*d*.

3. If R165. 14*a*. and $1\frac{7}{12}$*p*. be the discount of a debt of R2820, simple interest being at the rate of $3\frac{3}{4}$ per cent., how many months before due was the debt paid?

4. The price of gold is £3. 17*s*. $10\frac{1}{2}$*d*. per oz.; a composition of gold and silver weighing 18 lb. is worth £637. 7*s*., but if the proportions of gold and silver were interchanged, it would be worth only £259. 1*s*. Find the proportion of gold and silver in the composition, and the price of silver per oz.

5. By selling 4 dozen mangoes for 13 rupees, it was found that $\frac{3}{16}$ths of the outlay was gained; what ought the retail price per mango to have been in order to have gained 60 per cent.?

1889-90.

1. Simplify :— $\dfrac{5\frac{1}{2} \text{ of } \cdot\dot{2} \text{ of } 2\cdot\dot{5}71428\dot{8} - 1 \div (\frac{1}{5} + \cdot 5)}{1 - \frac{8}{15} \text{ of } \left\{ \cdot 5 + \frac{1}{2} \text{ of } \dfrac{\cdot 05}{\cdot\dot{1}42857\dot{7} \text{ of } 1\frac{1}{20}} \right\}}$

2. A rectangular cistern, whose length is equal to its breadth, is $5\frac{5}{9}$ feet deep and contains 5 tons of water. If a cubic foot of water weighs 1000 ounces, find the dimensions of the cistern.

3. *A*, *B*, and *C* can walk at the rate of 3, 4, 5 miles an hour; they start from Poona at 1, 2, 3 o'clock respectively; when *B* catches *A*, *B* sends him back with a message to *C*; when will *C* get the message?

4. If I borrow money at 3 per cent. per annum, interest payable yearly, and lend it immediately at 5 per cent. per annum, interest payable half-yearly (receiving compound interest for the second half-year), and gain thereby at the end of the year R660; what was the sum of money which I borrowed?

5. A person buys tea at 6 annas per seer and also some at 4 annas per seer. In what proportions must he mix them so that by selling the mixture at $5\frac{1}{4}$ annas per seer he may gain 20 per cent. on each seer sold?

1891-92.

1. Simplify :—

(i) $\dfrac{\frac{7}{18} \text{ of } \frac{91}{120} + \frac{5}{6} \text{ of } \frac{13}{35}}{5\frac{2}{77} \text{ of } \frac{132}{153} - \frac{299}{323} \text{ of } \frac{19}{23}}$.

(ii) $\dfrac{3\cdot 6\dot{4}2857\dot{1} - (\cdot 009923 + \cdot 0102 - \cdot 000123)\dfrac{\cdot 145}{\cdot 0056}}{\sqrt{34\cdot 5744} - \sqrt[3]{9\cdot 663597}}$.

2. Two passengers have together 5 cwt. of luggage and are charged for the excess above the weights allowed 5*s*. 2*d*. and 9*s*. 10*d*. respectively; but if the luggage had all belonged to one of them he would have been charged 19*s*. 2*d*. How much luggage is each passenger allowed to carry free of charge, and how much luggage had each passenger?

3. Two clocks *A* and *B*, whose rates are uniform, at noon yesterday indicated 11 hrs. 55 min. A. M. and 0 h. 2 m. P. M. respectively. *A* indicated the correct time at 9 P. M. yesterday and *B* at 6 A. M. this morning. When did *A* and *B* last agree and what time did they then indicate?

4. A person borrows two equal sums of money at the same time at 5 per cent. and $3\frac{3}{4}$ per cent. simple interest respectively, and finds that if he repays the former sum with interest on a certain date a year before the latter, he will have to pay in each case the same amount, *viz*. R736. Find the amounts borrowed.

1892-93.

1. What decimal of a rupee is ·964 pie? Find the value of ·97625 rupee.

Simplify :— $\dfrac{\frac{5}{14} - \frac{3}{7} \text{ of } \frac{7}{9}}{\frac{5}{18} + \frac{7}{18} \text{ of } 3\frac{1}{4} - (\frac{7}{8} \text{ of } \frac{8}{7} - \frac{1}{6})} + \dfrac{\frac{1}{3} \text{ of } \frac{1}{2} + \frac{2}{3} \text{ of } 5}{9\frac{1}{3} - 1\frac{2}{3}}$.

2. How long will two examiners, working 8 hours a day, take to look over the answers to this paper, if four examiners, working 5 hours a day, can do it in 8 days?

3. On a river, *B* is intermediate to and equidistant from *A* and *C*; a boat can go from *A* to *B*, and back, in 5 hours 15 minutes, and from *A* to *C* in 7 hours; how long would it take to go from *C* to *A*?

4. What income will a retired officer obtain in England, from one lakh of rupees, Indian Government $4\frac{1}{2}$ per cent. bonds, when for drawing and remitting it, his agents in India charge him 3 per cent., and exchange is at 1*s.* $2\frac{1}{4}$*d.* for the rupee?

5. Three equal glasses are filled with a mixture of spirits and water, the proportion of spirits to water in each glass being as follows: In the first glass as 2 : 3, in the second 3 : 4, and in the third 4 : 5. The contents of the three glasses are poured into a single vessel; what is the proportion of spirits to water in it?

1893-94.

(*Set in the Mofussil*).

1. Divide each of the numbers 2,572,125 and 4,061,250 by 125; and express as a decimal the first quotient divided by the second.

2. Find, by Practice, the value of 5 yd. $22\frac{1}{2}$ in. at £2. 1*s.* 2*d.* a yard.

3. If the carriage of 2 cwt. 1 qr. and 18 lb. of goods, for 56 miles, be £1. 1*s.*, what weight can be carried at the same rate, 200 miles for £4. 3*s.* 4*d.*

4. A man invests £3,000 in the 5 per cents. If after deducting an income-tax of 8*d.* in the pound, the man's clear income is £174, what is the price of the 5 per cents.?

5. A cistern is filled by two taps *A* and *B* in 4 hours and 6 hours respectively, and is emptied by a waste pipe *C* in 3 hours. When the cistern is half full, *A* and *B* are closed, and *C* is opened; after one hour, *B* is turned on; and after half an hour more, *A* is turned on. In what time after *C* is first opened, does the cistern become full?

6. A person buys two kinds of tea, at 5*s.* a lb. and 6*s.* a lb. respectively; and after mixing them he sells the mixture at 6*s.* 6*d.* a lb., thereby gaining 17 per cent. In what proportion does he mix them?

1893-94.

(*Set in Bombay*).

1. Reduce to their simplest forms:—

(i) $\dfrac{\frac{1}{2}+\frac{1}{3}-\frac{1}{4}}{\frac{1}{2}\text{ of }\frac{1}{3}\text{ of }\frac{1}{4}}$; (ii) $\dfrac{2}{3+\dfrac{4}{5-\frac{6}{7}}}$.

2. Find, by Practice, the value of 9 cwt. 3 qr. 24 lb. at £3. 5*s.* 8*d.* per cwt.

3. If 40 men, 60 women or 80 children can do a work in 6 months, in what time will 10 men, 10 women, and 10 children do one-third of the work?

4. A person invested £1,000 in the 3 per cents. at $90\frac{5}{8}$; but the price rising to $91\frac{1}{4}$, he sold out, and invested the proceeds in the $3\frac{1}{2}$ per cents. at $97\frac{1}{8}$; find the increase in his income.

5. A cistern can be filled by two pipes, *A* and *B*, in 12 minutes and 14 minutes, respectively, and can be emptied by a third, *C*, in 8 minutes. If all the taps be turned on at the same moment, what part of the cistern will remain unfilled at the end of 7 minutes?

6. Two clocks point to 2 o'clock at the same instant on the afternoon of 25th April; one loses 7 seconds, and the other gains 8 seconds, in 24 hours; when will one be half an hour before the other, and what time will each clock then shew?

1894-95.

1. When the number representing the year is a multiple of four, it is a leap year, consisting of 366 days, except when this number is a multiple of 100, in which case it is an ordinary year, consisting of 365 days, but when the number is a multiple of 400, it is again a leap year; on this supposition, calculate the number of days from the first January 1495 to 31st December 1891, both days inclusive.

2. A school of boys and girls consists of 453 children; the number representing the boys is $\cdot5\dot{2}$ of the number of the girls. How many boys were there?

3. Two-thirds of a certain number of poor persons received 1*s*. 6*d*. each, and the rest 2*s*. 6*d*. each; the whole sum spent being £2. 15*s*., how many poor persons were there?

4. If 3 men and 5 women do a piece of work in 8 days, which 2 men and 7 children can do in 12 days, find how long 13 men, 14 children and 15 women will take to do it.

5. *A* sells a house to *B* for R4860, thereby losing 19 per cent.; *B* sells it to *C* at a price which would have given *A* 17 per cent. profit. Find *B*'s gain.

6. The compound interest on one rupee is one quarter of a rupee at the end of three years; find the rate per cent. per annum, correct to two places of decimals; and calculate exactly the compound interest at the end of 9 years.

IV. THE PUNJAB UNIVERSITY. ENTRANCE PAPERS.

1875.

1. Write in figures one million, ten thousand and one. Subtract 397 from 1,163 and explain the process.

2. Shew that when any number is divided by nine the remainder is the same as when the sum of the digits is divided by nine.

3. State the rules for the multiplication and division of vulgar fractions. What is a complex fraction? and simplify.

$$(1)\quad \left\{\frac{8}{17}+\frac{3}{5}\text{ of }7\frac{1}{2}\right\} \div \frac{13}{17} \text{ and } (2)\ \frac{\frac{3}{5}}{\frac{8}{9}}+\frac{\frac{5}{7}}{\frac{5}{8}+7\frac{1}{2}}.$$

4. What is the value of ·3375 of an acre?

Reduce £1. 10s. 4d. to the decimal of two guineas.

5. Find the square root of 9,98,001 and that of 3·14159 to three places of decimals.

6. If five pumps each having a length of stroke of 3 feet, working 15 hours a day for 5 days, empty the water out of a mine; how many pumps with a length of stroke of $2\frac{1}{2}$ feet, working 10 hours a day for 12 days, will be required to empty the same mine; the strokes of the former pumps being performed four times as fast as those of the other?

1876.

1. How many revolutions will a cart wheel of three feet six inches diameter make in going a distance of 6 miles, the ratio of the diameter of a circle to its circumference being given as 1 : 3·14159.

2. A piece of land measuring 48 ghumas 3 kanals and 17 marlas of which 39 ghumas 4 kanals and 17 marlas are cultivated and the rest uncultivated is sold at the rate of R75/-a ghuma for cultivated and R35/-a ghuma for uncultivated land. What is the price of the whole?

3. The revenue of a village containing 15,756 acres of cultivated land is assessed at 13 annas an acre. What will the local rate of $6\frac{1}{4}$ per cent. on the land revenue payable by the village amount to?

4. A bania purchases 1,526 maunds of grain at 36 seers for a rupee. He sells one half at 26 seers the rupee; at what rate must he sell the remainder so as to clear 50 per cent. on the transaction?

5. Find the interest on 24,485 rupees for 1 year and 131 days at 12 per cent. per annum.

6. A man hires a workman on this condition that for every day he worked he should get one rupee but that for every day he was absent he should be fined 12 annas. When 356 days were past the workman was to receive R118. How many days had he worked?

1877.

1. If a pound of pure silver be worth 62 shillings, the shilling containing 222 parts of pure silver in 240, what will be the value in shillings of a rupee weighing 180 grains, the rupee containing 979 parts of pure silver in 1,000?

2. (a) How much is ·0125 of a day?

(b) Find the value of $3\frac{3}{8}+4\frac{7}{8}+1\frac{1}{16}+3\frac{13}{256}$.

Express the result both as vulgar and decimal fraction.

3. Divide ·10724 by ·003125 and extract the square root of the result to 3 places.

4 (*a*) What sum at simple interest will amount to R6,000 in 6 years at 4 per cent. per annum?

(*b*) How much Government paper of the six per cent. can be bought for R500 when the funds are at 94 and what dividend will be got on it yearly?

1878.

1. If 135 rupees 4 annas be divided equally amongst 24 persons what will each receive?

2. Define a vulgar fraction. By how much does the difference of $1\frac{1}{23}$ and $\frac{9}{15}$ fall short of their sum? Express the defect as a decimal of 7.

3. (*a*) Subtract ·03 from $\cdot\dot{0}\dot{3}$ and divide the result by $\cdot 10\dot{2}$.

(*b*) Shew that $\frac{1}{7+\frac{1}{16}} = \cdot 14159$ nearly.

4. A room whose height is 11 feet and length twice its breadth, takes 143 yards of paper 2 feet wide for its four walls; how much carpet will it require?

5. At what rate (simple interest) will 1,300 rupees amount to 1,381 rupees 4 annas in 15 months?

6. Find the square root of ·1 to 3 places of decimal. What number has ·01 for its square root?

1879.

1. (*a*) Show by an example that if the numerator and denominator of a fraction be divided by the same number, the valne of the fraction is not altered. (*b*) Reduce to their lowest terms $\frac{595}{1071}$ and $\frac{1547}{5712}$ and express their difference in decimal form.

2. Simplify $\dfrac{\frac{1}{4}+1\frac{1}{8}}{\frac{2}{7}+\frac{9}{11}} \div \dfrac{\frac{1}{3}+\frac{3}{4}}{\frac{1}{3}+\frac{2}{7}}$.

3. One cubic inch of water weighs 253·17 grains, while one cubic inch of air ·31 grain; find the number of cubic inches of water (to three places of decimals) that would be equivalent to one cubic foot of air.

4. (*a*) What portion of R34. 8*a*. is $\frac{3}{32}$ of $\frac{5}{6}$ of R50 − $\frac{7}{16}$ of R$10\frac{1}{2}$?

(*b*) Find (accurately to 4 places of decimals) the square root of ·001.

5. A rectangular field measures 6 acres and 960 yards; its length is 3 times its breadth; find the distance between the diagonal angles.

1881.

1. Distinguish between a vulgar fraction and a decimal fraction and show how to reduce one to the other.

2. Divide the continued product of ·021, ·0021 and 210 by that of ·14 and ·007; and extract the square root of 5·005 to four places of decimals.

3. Express $\dfrac{\frac{5}{8} \text{ of } 1\cdot\dot{5}}{2\cdot7 + \frac{2}{3} \text{ of } \cdot\dot{3}}$ of a rupee to the decimal of a guinea (=R$10\frac{1}{2}$).

4. A person withdrew R5,000 from a bank, which paid him interest at $5\frac{1}{2}$ per cent. and invested the money in the 6 per cent. Municipal Debenture at $103\frac{1}{2}$. Find the change in his income.

1883.

1. (*a*) Divide the difference of $\cdot4607$ and $\cdot00809$ by the difference of $6\frac{3}{16}$ and $5\frac{125}{128}$.

(*b*) Prove that $\dfrac{3+4}{4+5}$ is greater than $\frac{3}{4}$ and less than $\frac{4}{5}$.

2. Divide $\frac{1}{3}\left[3+\frac{1}{3}\left\{3+\frac{1}{3}(3+1\frac{1}{3})\right\}\right]$ by $\cdot125$.

3. (*a*) Shew that the value of a decimal is not altered by adding ciphers to the right hand side.

(*b*) Find the value of $7\cdot\dot{5}\dot{7} \times \cdot3\dot{6} - 2\cdot3\dot{4}\dot{5}$ in vulgar fraction.

4. A railway train having travelled at $\frac{7}{8}$ of its proper speed reaches its journey's end $2\frac{1}{2}$ hours behind time; in what time should the journey have been done?

5. Five hundred boys are distributed in three houses; the smallest house contains $\frac{7}{25}$ of the whole number and the largest contains $\frac{10}{7}$ of the smallest: what is the number in each?

6. A person realises R185500 by selling his $3\frac{1}{2}$ per cent. stock at $92\frac{3}{4}$. He invests one-fifth of the realised money in the 4 per cents. at 96 and the remainder in 3 per cents. at 90. What is the difference in his income by this transaction?

1884.

1. Multiply and divide R625 by R25, if you think the operations possible. Give your reasons.

2. State and explain the rules for multiplying and dividing one decimal number by another; exemplify by multiplying $\cdot0256$ by $1\cdot05$ and $\cdot105$ succesively, and dividing the results by $\cdot00105$.

3. Simplify $$\frac{4}{7\cdot5}\left\{\frac{\cdot\dot{3}+\dfrac{\cdot75}{4\cdot5}}{\dfrac{1-\cdot25}{2-\cdot5}}+\frac{7}{8}\right\}.$$

4. Extract the square root of $\dfrac{1000\cdot20001}{1000}$.

5. Find by *practice* the value of 45 md. 22 sr. and 10 ch. of grain at R1. 6*a*. per maund.

6. The assets of a bankrupt consist of R9560. 4*a*., a bankshare of R1200 quoted at $107\frac{5}{8}$, and an undiscounted bill of R3225, due 4 months,

hence at 4 per cent. per annum simple interest; his liabilities amount to R25014. How much in the rupee can he pay his creditors?

7. Compare the ratios $\frac{\sqrt{5}}{\sqrt{3}}$ and $\frac{31}{27}$.

1885.

1. Simplify $\frac{\frac{1}{3}-\frac{1}{5}\div\frac{2}{8}}{\frac{1}{4}+\frac{1}{6}}+\frac{\frac{5}{3}\div\frac{1}{10}}{\frac{1}{5}-\frac{1}{5}\text{ of }\frac{1}{3}}$ of $\frac{19}{69}-\frac{31}{350}$, and find how many times ·027 can be taken from 3·33.

2. Convert $\frac{13}{20\times8}$ into a decimal: why is the result a terminating and not a recurring decimal? Subtract ·03 from $\cdot\dot{0}\dot{3}$ and divide the result by $\cdot0\dot{0}\dot{7}$.

3. Find, by Practice, the value of 12 maunds 8 seers 4 chataks of ghee at R72. 8*a*. per maund.

4. A legacy of £1901. 5*s*. is to be distributed amongst a number of persons, in such a way that each shall receive as many shillings as there are persons; what will be the portion of each?

5. Find the Least Common Multiple of 35280 and 592704. What is the smallest number of square yards which can be measured either by roods or square chains?

6. Four per cents. are offered at R98, five per cents. at R120$\frac{5}{8}$; which is the better investment? How much is one investment when the difference of income is R30?

1886.

1. Simplify $\frac{4\cdot\dot{4}-2\cdot\dot{8}\dot{3}}{1\cdot\dot{6}+2\cdot\dot{6}2\dot{9}}$ and extract the square root of the result to three places of decimals.

2. Reduce $\frac{5}{7-\frac{1}{2-\frac{1}{2}}}$ to a decimal fraction correct to four places.

Is there anything to suggest that the result will be a terminating or a recurring decimal?

3. What fraction of £51,120. 18*s*. is 17·975 of £71. 2*s*.?

4. A clever housekeeper went out shopping and found that 2 cocoanuts were selling for the same price as 144 plums; she bought half a dozen cocoanuts, exchanged one of them for 5 melons, and a couple of melons for 5 oranges; she then gave 3 oranges for 42 limes, and finally secured a couple of plums for 5 limes. Has she gained or lost in buying the plums?

5. Distinguish between Interest and Discount.

Find the Interest and Discount of R1,450. 8*a*. for 3 years at $4\frac{1}{2}$ per cent. per annum, simple interest.

1887.

1. (*a*) Write in figures—three billions, five millions four hundred and nine thousand and sixty-two.

(*b*) Write out measures of length and surface, both English and Indian.

(*c*) Express an acre as the decimal of a *bigah*, a cubit being equivalent to 18 inches.

2. Owing $\frac{4}{17}$ of an estate I sold $\frac{3}{11}$ of $\frac{2}{9}$ of my share for £$\frac{400}{33}$; what is the value of $\dfrac{1\frac{3}{5}}{4\frac{1}{4}}$ of $\frac{3}{8}$ of the estate at the same rate ?

3. A merchant having 100 maunds of grain sold 50 maunds at R9 per maund, and thereby gained $7\frac{1}{2}$ per cent. At what rate should he sell the remainder 50 that he may gain 10 per cent. on the whole ?

4. A merchant in trade successively admits three partners at the end of 3 months, 5 months, and 6 months respectively from the opening of the business. The capitals embarked by them were R400, R450, R480 and R495 respectively. After 6 months more, the profit was found to be R1,000. Divide this rateably between the partners.

5. What sum of money invested in the 4 per cents. at par would realise the same income as R10,000 invested in the $4\frac{1}{2}$ per cents. at 102 ?

6. Extract the square root of—

$$\frac{\cdot 0025+1\cdot\dot{6}}{3\cdot\dot{6}-2\cdot 5}\text{ of }\frac{\cdot 42\dot{6}+2\cdot 625}{12\cdot 7-10\cdot 2}.$$

1888.

1. Simplify

$$\frac{1}{1-\frac{1}{12}}-\frac{1-\frac{7}{22}}{2-\frac{1}{3}}+\frac{1\frac{2}{5}}{4-1\frac{1}{2}}-\frac{6\frac{3}{8}-\frac{3}{4}}{6\frac{1}{4}}\times\left\{\frac{1}{3}-\frac{\frac{1}{2}-\frac{1}{3}}{4\frac{3}{4}-3\frac{2}{9}}\right\}.$$

2. Express the difference between $\cdot\dot{3}7\dot{8}$ of 13*s.* $10\frac{1}{2}$*d.* and $\cdot\dot{3}7\dot{8}$ of 16*s.* 6*d.* as a decimal of $\cdot 42\dot{6}\times\dfrac{3\cdot\dot{3}}{.8}\times\dfrac{\cdot 3}{\cdot 73\dot{5}}\times\dfrac{\cdot 147\times 4\cdot 4}{11\cdot 1}$ of £1. 17*s.* 6*d.*

3. Four men working together all day, can finish a piece of work in 11 days, but one of them having other engagements can work only half time, and another only quarter time. How long will it take the men to complete the work ?

4. A merchant sells his goods worth R500 directly for R600 giving three months' credit. Find his profit per cent., interest being calculated at 12 per cent. per annum.

5. Find the value of $\dfrac{12+\sqrt{\cdot 009}}{1-\sqrt{\cdot 4}}$ correct to 3 places of decimals.

1889.

1. Express 80080080·0975 in words and give the local value of the digits. What decimal of R75 is R24. *2a.* *6p.* ?

What is the least number which when divided by 22, by 88, by 132 and by 198 gives in each case remainder 7 ?

2. Why is the fraction $\frac{\frac{3}{5}}{8}$ objectionable ?

After walking $4\frac{1}{2}$ miles, a man has accomplished

$\dfrac{2\frac{1}{2} - 1\frac{1}{5} \text{ of } 2\frac{1}{4} + 1\frac{7}{8}}{(2\frac{1}{2} - 1\frac{1}{3}) \text{ of } (2\frac{1}{4} + 1\frac{7}{8})}$ of $\dfrac{\frac{2}{11} + \frac{1}{2}}{\frac{4}{7} - \frac{1}{11}}$ of his journey ; how far has he still to walk ?

3. Add together $\dfrac{5{\cdot}7}{1{\cdot}52}$ and $\dfrac{{\cdot}011\dot{2}}{{\cdot}74}$.

Five bells which commence tolling together, toll at intervals of 1·2, 1·5, 1·75 1·8, 2·1 seconds respectively ; after what interval will they again toll together ?

4. Define "present worth."

A farmer buys 57 sheep for R120, payable at the end of 12 months, and sells them directly at R1. *12a.* ready money ; what does he lose by the transaction, supposing the interest of money to be 5 per cent. ?

5. Show which is greater $\sqrt{2}$ or $\sqrt[3]{3}$.

Which is the better investment, 3 per cents. at $83\frac{1}{2}$ or $3\frac{1}{2}$ per cents. at 3 per cent. discount ?

1890.

Simplify (*a*) $\dfrac{\dfrac{\frac{2}{5}}{1 - \frac{1}{25}} + \frac{1}{3} + \frac{1}{7}}{1 - \frac{1}{7}\left(\dfrac{\frac{2}{5}}{1 - \frac{1}{25}} + \dfrac{1}{3}\right)}$.

(*b*) $\dfrac{{\cdot}47 - ({\cdot}5 - {\cdot}0303)}{{\cdot}0873 - ({\cdot}0083 + {\cdot}06)}$.

2. What part of $\frac{3}{8}$ of 5 cwt. is $\frac{1}{100}$ of a ton ?

Express $\cdot 3\dot{7}\dot{8}$ of *16s.* *6d.* as a decimal of $\cdot 42\dot{6}$ of £1. *17s.* *6d.*

3. A man bequeathed $\frac{5}{12}$ of his property to one son, 30 per cent. of the remainder to another, and the surplus to his widow. The difference of his son's legacies was £784. How much did the widow receive ?

4. A ship with 1200 men on board had sufficient provisions to last 17 weeks. The survivors of a wreck having been taken aboard, the provisions were consumed in 15 days. How many men were taken aboard ?

5. At what price must a person invest in the 4 per cent. Government Promissory Note, so that after paying income-tax at the rate of 5 pies in the rupee, he may receive $4\frac{1}{2}$ per cent. on his investment ?

6. *A* and *B* travel together 120 miles by rail. *A* takes a return ticket for which he has to pay one fare and a half. Coming back they find that *A* has travelled cheaper than *B* by 4*a*. 2*p*. for every 100 miles. Find the fare per mile.

1891.

1. Simplify :—

(1) $$\frac{\frac{1}{7}+\frac{1}{3}+\dfrac{\text{[illegible]}}{1-\frac{1}{\text{[illegible]}}}}{1-\frac{1}{7}\text{ of }\left(\frac{1}{3}+\dfrac{\text{[illegible]}}{1-\text{[illegible]}}\right)}.$$

(2) $$\frac{3\sqrt{2}-2\sqrt{3}}{3\sqrt{2}+2\sqrt{3}}+\frac{\sqrt{12}}{\sqrt{3}-\sqrt{2}}.$$

2. Express 7·7 oz. + ·075 cwt as decimal of 2·2$\dot{5}$ of ·2$\dot{7}$ of a ton.

3. A sum of money invested at 5 per cent. per annum simple interest amounts in 6 years to R1326 ; in what time will it amount to R1530 ?

4. What is discount ? Distinguish between true and commercial discount.

The interest on a certain sum at 5 per cent. per annum for a certain time is £50, and the discount at the same rate for the same time is £4[illegible]. Find the sum and the time.

5. Nine gallons are drawn from a cask full of wine, it is then filled with water. Nine gallons of the mixture are drawn, and the cask is again filled with water. The quantity of win now left in the cask is to that of the water in it as 16 : 9. How much does the cask hold ?

1892.

1. Find by how much the square root of $9+\dfrac{1}{1+\dfrac{1}{7+\text{[illegible]}}}$ differs from [illegible].

Which of these comes nearest to $3+\frac{1}{10}\sqrt{2}$?

2. Find the value of

$$\left(\frac{\cdot0019}{3\cdot1\dot{6}}\text{ of }\frac{4\cdot\dot{4}}{\cdot0005}\right)\div\left(\frac{8\cdot\dot{8}}{7}\text{ of }\frac{4}{5\cdot625}\right).$$

3. A stream which flows at a uniform rate of 1·109 miles an hour, is 20 yards wide, the depth at a certain ferry being 6 feet : how many gallons pass the ferry in a minute ? (Each gallon contains about 277¼ cubic inches).

4. A person invests £14970 in the purchase of 3 per cents. at 90 and 3½ per cents. at 97. His total income being £500, how much of each stock did he buy ?

5. A spirit merchant buys 80 gallons of whisky at 18*s*. per gallon, and 180 gallons more at 15*s*. per gallon, and mixes them. At what price must he sell the mixture to gain 8⅓ per cent. upon his outlay ?

1893.

1. Add :—

R.	As.	P.
3436	12	2
5242	10	3
248	6	9
431	13	5
5302	11	$4\frac{1}{2}$
6789	8	$1\frac{1}{2}$
5001	15	$6\frac{3}{4}$
136854	7	2
298	9	$4\frac{1}{2}$
836993	1	$9\frac{3}{4}$

2. Multiply 319·9657 by ·04216.

3. Find the value of $\dfrac{\sqrt{(2-\sqrt{2})}}{\sqrt{(2+\sqrt{2})}}$ correct to 5 places of decimals.

4. Calculate the income-tax on R566. 10 annas 8 pies at 5 pies per rupee.

5. A local train which travels at the rate of twenty-four miles an hour, leaves Lahore at twenty minutes past eight and reaches Amritsar at five minutes past ten the same morning. It stops at Mianmir for ten minutes and at each of three other stations for five minutes. Find the distance between Lahore and Amritsar.

1894.

1. Convert [illegible] and [illegible] into circulating decimals and point out the relation between the figures in their periods.

2. The sides of a rectangle are as 3 : 4 and the area is 1452 square feet. Find its length and breadth.

3. Exchange R7080 for English money at 1s. 3[illegible]d. per rupee.

4. What is discount? How is it commonly calculated? If a sum of R1,000 becomes due three months hence, what is its present value as commonly calculated, and what as correctly calculated, interest being reckoned at 5 per cent.?

5. Find the square root of 101 correct to five places of decimals.

1895.

1. Divide $\dfrac{48\frac{4}{7}}{1085\frac{5}{10}}$ by $\dfrac{7\frac{3}{11}}{174\frac{1}{17}}$, and reduce the quotient to a recurring decimal.

2. The Imperial gallon contains 277·27 cubic inches, and a cubic foot of water as its maximum density weighs 62·42 lb.; find the weight of a pint of water correctly to two places of decimals.

3. The capital of a firm consists of £713. 3s.; £964. 17s.; £2391. 3s. subscribed by three partners; divide £2231 among them in proportion to their several capitals.

4. Find the square root of 5 correctly to seven places of decimals.

5. The area of a rectangular field is $\frac{3}{4}$ of an acre ; and its length twice its breadth ; determine the lengths of its sides approximately.

V. UNIVERSITY OF ALLAHABAD. ENTRANGE PAPERS.

1889.

1. Define a fraction and shew that $\frac{1}{3}=\frac{3}{9}$.

By how much does the difference of $1\frac{1}{28}$ and $\frac{4}{13}$ fall short of their sum ? Express the defect as a decimal.

2. (*a*) Simplify $\dfrac{2\frac{1}{3}-1\frac{1}{2} \text{ of } 1\frac{1}{5}-1\frac{1}{7}}{(3\frac{1}{8}-1\frac{1}{2}) \text{ of } (1\frac{1}{5}-1\frac{1}{7})}$.

(*b*) Subtract ·03 from $\cdot\dot{0}\dot{3}$ and divide the result by $\cdot 10\dot{2}$.

3. Find the square root of ·001 to four places of decimals. What number has ·1 for its square root ?

4. What sum of money will amount to ₨1,381 . 4 . 0 in 15 months at 5 per cent. per annum simple interest ?

5. How long will it take to walk along the four sides of a square field which contains 16 acres 401 square yards, at 3 miles an hour ?

6. *A* and *B* complete a piece of work in 8 days ; *B* and *C* do the same in 12 days ; and *A*, *B* and *C* finish it in 6 days. In how many days will *A* and *C* complete the work ?

7. *A* who travels $3\frac{1}{2}$ miles an hour starts $2\frac{1}{3}$ hours before *B* who goes the same road at $4\frac{1}{2}$ miles an hour ; where will *B* overtake *A* ?

1890.

1. Multiply ·347695 by 2·0026, and divide the product by ·01905.

2. Simplify $2\frac{3}{8}+3\frac{1}{3}-5\frac{5}{6}+2\frac{1}{4}-1\frac{1}{12}$.

3. Find, by Practice or otherwise, the value of 2345 md. 27 seers 10 ch. of wheat at ₨3. 10. 8 per md.

4. Extract the square root of $1-(\cdot 00135)^2$ to 5 places of decimals.

5. The weight of a cu. in. of water is 253·17 grains, that of a cu. in. of air is ·31 grains ; find to 3 places of decimals how many cu. in. of water are equal in weight to one cu. ft. of air.

6. On measuring a distance of 32 yd. with a rod of a certain length it was found that the rod was contained 41 times with $\frac{1}{2}$ an inch over. How many inches will there be over in measuring 44 yd. with the same rod ?

1891.

1. Define "Notation," "Numeration" ; and prove that "three times four" = "four times three."

2. Reduce to a single fraction :—

$$\frac{919\frac{2}{17}}{7\cdot9\dot{5}\dot{4}}+\frac{4\cdot\dot{1}0\dot{0}}{442\frac{40}{37}}+\frac{7}{11}\text{ of }\cdot07344.$$

3. The wine in a pipe when full is worth £19. 9s. 9d. How much has leaked away if what is left is worth £9. 16s. $7\frac{25}{27}$d. ?

4. In discounting a bill, what do you mean by "The Banker's profit"? If the simple interest on £923. 18s. $1\frac{1}{2}$d. amounts to £17. 9s. $3\frac{3}{4}$d. exactly in 138 days, what is the rate of interest per cent. per annum ?

5. Extract the square roots of 99,980,001 ; and of $60\frac{81}{105}$.

1892.

1. How is a fraction affected by adding the same number to the numerator and the denominator ?

Prove that $\frac{3+4}{4+5}$ is greater than $\frac{3}{4}$ and less than $\frac{4}{5}$.

2. (a) Divide $\frac{1}{3}[3+\frac{1}{3}\{3+\frac{1}{3}(3+1\frac{1}{2})\}]$ by $\cdot125$.

(b) Reduce [illegible] and [illegible] to their lowest terms and express their difference as a decimal.

3. Fourty men finish a piece of work in 40 days, if 5 men leave the work after every tenth day, in what time will the whole work be completed ?

4. Find the difference between the Simple Interest and Discount of £330 in 4 years at $2\frac{1}{2}$ per cent. per annum.

5. Extract the square root of $\frac{1000\cdot2001}{1000}$.

1893.

1. Two recurring decimals are added together ; prove that the number of digits in the period of the result, cannot exceed the product of the numbers of the digits in the original periods.

2. Find the value of $\cdot\dot{5}\dot{4}$ of $\cdot30\dot{7}\dot{2}$ of 1 mile 5 fur. 30 poles.

3. Multiply Rs. 2. anna 1. by $\frac{\frac{4}{5}+\frac{6}{7}+\frac{13}{15}+\frac{19}{21}}{\frac{1}{5}+\frac{3}{7}+\frac{7}{15}+\frac{13}{21}}$.

4. Find by Practice the cost of 10 cwt. 3 qr. 23 lb. 8 oz. at £1. 5s. 8d. per cwt.

5. A sum of money was divided amongst 5 people ; 4 of them received respectively $\cdot15$, $\frac{1}{10}$, $\cdot1$, $\frac{2}{5}$ of the whole, while the 5th received £105. 3s. 6d. What was the sum divided ?

6, An oz. of standard gold, one-twelfth of which is alloy, is worth £3. 17s. $10\frac{1}{2}$d. ; how many sovereigns would be coined from 36 lb. 8 oz. of pure gold ?

7. Find the square root of 6246·057024 and of $71\frac{1}{144}$.

1894.

1. (*a*) A multiplication sum having been worked is partially rubbed out ; the figures that remain are the entire multiplicand 999 and the last three digits 193 in the product. Restore the complete work.

Simplify $\frac{1}{1\frac{1}{20}} \times \frac{1 + \cdot 0025 \times \cdot 05}{1 \cdot 0025 - \cdot 05} - \frac{45 \times \cdot \dot{3}\dot{5}}{8}$.

2. (*a*) What decimal of R100 must be added to $\frac{1}{140}$ of R5 . 10 . 8 that the sum may be 10 annas ?

(*b*) Extract the square root of 25·6.

3. Two trains start at the same time from Mirzapur and Delhi and proceed towards each other at the rates of 16 and 21 miles per hour respectively. When they meet it is found that one train has travelled 60 miles more than the other. Find the distance between the two stations.

4. Two years and six months ago, I borrowed a sum which with simple interest at 6 per cent. per annum now amounts to R638 . 4 . 0. Find the sum.

1895.

1. (*a*) Explain what is meant by the following terms :—

Prime factors ; *common measure* ; *common multiple* ; *lowest common multiple*.

(*b*) A courtyard 452 feet long and 404 feet wide, is to be paved with square stones all of one size. What is the largest size which can be used ?

2. (*a*) Simplify $\frac{5 \cdot 75}{4 \cdot 25}$ of $\frac{1}{4} \div \frac{5}{7} + \frac{1}{8} \times \frac{2}{3} - \frac{1}{2}$.

(*b*) Find the square root of 3·1415926 to four places of decimals.

3. The *difference* between the Interest for 4 months, and the Discount, on a certain sum due in 4 months at 4 per cent., is one rupee. What is the sum ?

4. A merchant sells silk of two qualities which cost him R5. 5*a*. 4*p*. and R4. 4*a*. 4*p*. per yard, respectively. The selling price of the latter is two-thirds that of the former, but the quantity sold is double and the marchant gains 25 per cent. on the whole. Calculate the selling price per yard of each.

5. A policeman goes after a thief who has 100 yard's start ; if the policeman run a mile in six minutes, and the thief a mile in ten minutes, how far will the thief have gone before he is overtaken ?

1896.

1. Simplify

(*a*) $5 - 5 \times \frac{2 + 1\frac{1}{5}(2 + 1\frac{1}{6})}{1\frac{1}{5} + 2(2 + 1\frac{1}{6})}$.

(*b*) $\frac{\cdot 125 \times (\cdot 175 \text{ of } \cdot \dot{2}8571\dot{4})}{\cdot 00025}$.

2. (*a*) Express $\frac{3}{4}$ of 7*s.* 6*d.* + 1·25 of 5*s.* − ·54$\dot{5}$ of 9*s.* 2*d.* as a decimal fraction of £10.

(*b*) Extract the square root of 40000·400001.

3. What is an aliquot part of a quantity?

Find, by Practice, the time of building a wall 27 yards long, 1 yard thick and 6 ft. high, of which one cubic yard is built in 3 hours 18 minutes and 45 seconds.

4. How far shall I ride with a friend who leaves Allahabad at 9 A. M. and will drive to Karchana which is 10 miles from Allahabad in one hour, that I may, by walking back at the rate of 4 miles an hour, reach home at 11-30 A. M?

5. *A* owes *B* R1435 due at the end of 4 months, R630 due at the end of 8 months, R860 due at the end of a year. *B* wants his money forthwith. What ought *A* to pay him reckoning interest at 7½ per cent.?

1897.

1. What is the largest number which divides both 2397 and 2491 without remainder? What is the smallest number which is divisible by both of these numbers?

2. State and prove the rule for pointing in multiplication of decimals. Why is the removal of the decimal point one place to the right equivalent to multiplication by 10? Illustrate your answer by comparing the numbers 23·015 and 230·15.

Find the square root of ·0802$\dot{7}$.

3. A person lent another a sum of money for 72 days at 3 per cent. per annum. At the end of that time he received £293-12*s.*-0½*d.* What was the sum lent?

4. The compound interest on a sum of money for 3 years at 5 per cent. is £331-0*s.*-3*d.*; what is the simple interest?

5. If a rupee is worth one shilling and three pence half-penny, and a shilling is worth 1·25 francs, what is the value in francs of 1,365 rupees?

ANSWERS TO EXAMPLES.

Examples. 1.

1. Ten; sixteen; forty-eight; ninety-nine; seventy-six; forty-three; fifty; thirty-one; sixty-two.

2. One hundred; one hundred and eleven; nine hundred and two; six hundred and twenty; three hundred; one hundred and three; two hundred and thirty-four; one hundred and thirty.

3. Nine thousand, two hundred and sixteen; five thousand, four hundred and nine; five thousand and four; one thousand and eleven; one thousand, two hundred and ten; nine thousand; nine thousand, nine hundred and ninety-nine.

4. Twelve thousand, three hundred and forty-five; twenty thousand, one hundred and three; forty thousand and forty; fifty thousand and one; ninety thousand, six hundred; eighty-nine thousand, three hundred and forty-six.

5. Five hundred thousand; seven hundred and eight thousand, nine hundred; one hundred and two thousand and thirty; three hundred and nine thousand, eight hundred and nine; three hundred and seventy-nine thousand, five hundred and eighty-six.

6. Seven million, two hundred and thirty-four thousand, six hundred and fifty-one; seven million, ninety thousand, seven hundred and nine; nine million; seven million, eight hundred thousand and forty; three million, five hundred and sixty-seven thousand, eight hundred and ninety-one.

7. Thirty-two million, five hundred and sixty-seven thousand, eight hundred and ninety-two: thirty-four million, eighty-three thousand and ninety-two; ninety-million, nine thousand; fifty-five million, five hundred thousand and fifty-five.

8. Seven hundred and eighty-nine million, three hundred and forty five thousand, six hundred and twenty-one; three hundred and ninety million, eighty-five thousand; two hundred and twenty-two million.

9. Seven thousand and nine million, fifty-six thousand, seven hundred; three thousand two hundred and fifty-nine million, two hundred and eighty-seven thousand, eight hundred and ninety-one; eight thousand and seventy million, eighty-eight thousand, two hundred.

10. Thirty-two thousand and five hundred million, ninety-four thousand and one; three hundred and eight thousand five hundred and six million, eight thousand, two hundred and thirty; one billion, three hundred and fifty-seven thousand nine hundred and

eighty-six million, four hundred and twenty-eight thousand, one hundred and twenty-three.

11. 70, 2 ; 300, 50, 9 ; 4000, 200, 3 ; 70000, 800, 9 ; 1000000000, 300000000, 400000, 50000, 700, 80, 9 ; 3000000000000, 70000000000, 900000000, 4000000, 70000, 8000, 20, 3.

12. Counting from left, the zeros respectively indicate the absense of—thousands, tens ; tens of millions, hundreds of thousands, tens of thousands, hundreds, units ; tens of thousands of millions, thousands of millions, tens of millions, thousands, tens.

13. (10,000) ten thousand ; (9,999) nine thousand, nine hundred and ninety-nine.

Examples. 2.

1. 13 ; 17 ; 19 ; 12 ; 11.
2. 23 ; 34 ; 40 ; 27.
3. 77 : 90 ; 84 ; 63.
4. 342 ; 486 ; 504 ; 900.
5. 203 ; 430 ; 555 ; 400.
6. 892 ; 704 ; 640 ; 512.
7. 7,835 ; 9,028 ; 6,009 ; 4,000 ; 6,085.
8. 5,992 ; 8,074 ; 2,003 ; 4,040 ; 3,403.
9. 1,200 ; 80,008 ; 18,454 ; 36,012 ; 90,000.
10. 20,070 ; 30,008 ; 54,400 ; 16,004.
11. 405,000 ; 800,040 ; 702,074.
12. 3,000,904 ; 9,000,400 ; 15,000,050 ; 108,003,004 ; 4,005,000.
13. 5,000,700,028 ; 315,764,009,003.
14. 3,000,000,000,050 : 405,000,010,020,007 ; 1,000,001,001,000 ; 6,000,000,000,006.
15. 512,255,762,713,473.
16. 12,000,000,000,012 ; 700,000,000,700,700 ; 3,000,003,003,303.
17. 7,305,000,502,006,024 ; 47,000,047,047,047.
18. 1,000,000 ; 99,999.
19. The number expressed in figures is 7707 ; therefore (counting from left), the first boy's mistake consisted in writing three ciphers unnecessarily to the right of the first 7, and two ciphers instead of one to the right of the second 7 ; the second boy's mistake consisted in omitting to write a cipher to the right of the second 7.

Examples. 3.

1. Three lacs, forty-five thousand, five hundred and forty-three ; thirty lacs, twenty thousand and fifty ; seventy-nine lacs, ninety

thousand, five hundred and seventy, seventy lacs, fifty thousand, three hundred and four.

2 One crore, twenty-three lacs, forty five thousand six hundred and seventy eight; thirty crores, fifty-seven lacs, fifty thousand and eighty, four crores, fifty lacs

3 Twenty-three crores, seventy-eight thousand and one, seven hundred and eight crores, nine lacs, four thousand and eighty, three hundred and seventy nine crores, forty eight lacs, fifty seven thousand, six hundred and twelve

4 Eight hundred and twenty seven crores, forty lacs, fifty-seven thousand and nine, three hundred and fifty crores, one thousand, two hundred and thirty, three hundred and ten crores, thirty seven lacs, five thousand and forty

5. One hundred and twenty three crores, forty five lacs, sixty-seven thousand, eight hundred and ninety, six hundred crores seven lacs, eighty nine thousand, five hundred and one crores, seven lacs, two thousand and nine

6 1,14,000, 78,00,000, 15,04,050, 7,00,007

7. 1,00,00,500, 28,03,00,004, 20,00,00,000, 1,01,01,001

8. 300,05,04,000, 101,01,00,101

9 328,17,45,715 **10** 705,17,24,738.

11. One hundred thousand, ten lacs, ten million

12. 103,028,481 = 10,30,28,481 which is read—ten crores, thirty lacs, twenty-eight thousand, four hundred and one

13. 103,07,00,704 = 1,030,700,704 which is read—one thousand and thirty million, seven hundred thousand, seven hundred and four.

Examples. 4

1. 6. **2.** 9. **3** 49 **4.** 99 **5.** 75
6. 264. **7.** 609. **8.** 664. **9** 1990. **10.** 60010.
11. 2764 **12.** XLIV. **13.** LXVI. **14.** LXXIX
15. LXXXIII. **16.** CXLIX. **17.** CDXXXVI.
18. CMXC. **19.** MCCC[illegible]. **20.** $\overline{\mathrm{V}}$DCLXX.
21. MMMCXLIX. **22** XL[illegible]CMLXXVIII. **23.** $\overline{\mathrm{M}}$.

Examples. 5.

1. 21[illegible] **2.** 30. **3.** 31. **4.** 29. **5.** 34.
6. [illegible] **7.** 99. **8.** 77. **9.** 140. **10.** 163.

11. 11323 12. 1151 13. 792. 14. 2727. 15. 2000.
16. 141.9. 17. 9996. 18. 3674. 19. 5620. 20. 4696.
21. 146175. 22. 59038 23. 234671. 24. 379462.
25. 45271. 26. 2262514 27. 920114. 28. 982255.
29. 7474095. 30. 39679341. 31. 42450564. 32. 496651.
33. 92439. 34. 8882862. 35. 951979. 36. 531284.
37. 5694685 38. 311989. 39. 9925098. 40. [illegible]
41. 74307. 42. 102469451. 43. 765168567. 44. 3129223218.
45. 46451330. 46. 3930. 47. 1890 48. 365.
49. 741 50. 2040 51. 138187 52. 42004 rupees.
53. 7193165 maunds. 54. [illegible] 55. 163554

Examples.

1. 43 2. 52. 3. 222 4. 543. 5. 4321.
6. 25. 7. 49 8. 8 9. 9. 10. 33
11. 159. 12. 90 13. 178. 14. 459 15. 315
16. 4641 17. 47017 18. 30532 19. 27273. 20. 41976.
21. 2679 22. 689357 23. 687590 24. 735347.
25. 6499247. 26. 5546 27. 85416. 28. 707467.
29. 3562. 30. 1. 31. 688881. 32. 390794.
33. 61059 34. 999981; 999695; 990525; 900554; 956500.
35. 92954. 36. 99971. 37. 9998999 38. 9921.
39. 83 years. 40. In 1612. 41. 923. 42. 117681 rupees.
43. 325 rupees. 44. 9466 rupees. 45. 16516.
46. 777101. 47. 6390. 48. 2000.
49. 35242 rupees. 50. 30000600. 51. 4503600

Examples. 7.

1. 458. 2. 62784. 3. 2740. 4. 288. 5. 19835.
6. 970. 7. 9960. 8. 14086. 9. 92788. 10. 99803.

Examples. 8.

1. 46. 2. 96. 3. 64. 4. 195. 5. 282.
6. 523. 7. 784. 8. 685. 9. 765. 10. 987.
11. 2835. 12. 7911. 13. 19470. 14. 35445.
15. 73648. 16. 315824. 17. 623245. 18. 769527.

19. 68158 ; 102237 ; 136316 ; 170395 ; 204474 ; 238553 ; 272632 ; 306711 20. 3625.

Examples. 9

1. 10770. 2 281400. 3 195250. 4. 421800. 5 35100
6. 5760300. 7. 21010000 8. 81036000. 9 183018000
10. 656550 ; 5836000 ; 5100,000 ; 437700000 ; 3647500000.

Examples. 10.

1. 20250. 2 88592. 3. 51060. 4. 1715340
5. 7920848 6. 7845984. 7. 501264. 8. 2877420.
9. 41269151. [illegible] 712823175. 11 546962,550
12. 8741795904. [illegible] 60956040000 14 73866065616.
15. 42788337730 [illegible] 77164533905 92 17 2223726225000
18. 389341782447. 19. 29333925 00000. 20 8784920736579
21. 2247882292480. 22. 27706959000. 23. 64834211900
24. 581199247904. 25. 1061228 3522500. 26 234916991512.
27. 83779349118000. 28. 47619. 29 45708.
30. 93652. 31. 99148 32 73350. 33. 140624.
34. 230690. 35. 505260. 36. 82764. 37. 711360.
38. 2170671. 39. 316875 rupees. 40. 10727350.
41. 20692 maunds. 42. 33114. 43. 3744.

Examples. 11.

1. 432. 2 4720645. 3. 16905000. 4. 1905700.
5. 1153800. 6. 44274384. 7. 1314. 8. 86400.
9. 3200. 10. 399735. 11. 9425. 12 2208.

Examples. 12.

1. See the Multiplication Tables.
2. 576. 3. 2500. 4. 4624. 5. 10000.
6. 12544. 7. 61504. 8. 531441. 9. 763876.
10. 1 ; 8 ; 27 ; 64 ; 125 ; 216 ; 343 ; 512 ; 729 ; 1000 ; 1331 ; 1728 ; 2197 ; 2744 ; 3375 ; 4096 ; 4913 ; 5832 ; 6859 ; 8000.
11. 804357. 12. 1000000. 13. 679151439.
14. [illegible] 15. 29503629. 16. 62913.

Examples. 13.

1. 188.	2. 4617.	3. 3542, rem. 1.
4. 2333, rem. 1.	5. 2675.	6. 30042.
7. 20511, rem. 1.	8. 8203, rem. 1.	9. 11419, rem. 2.
10. 2469.	11. 20040.	12. 15555, rem. 2.
13. 15067, rem. 1.	14. 14557, rem. 3.	15. 13155, rem. 4.
16. 541, rem. 2.	17. 6569, rem. 3.	18. 4640.
19. 4809, rem. 2.	20. 4313, rem. 5.	21. 2005, rem. 2.
22. 8013, rem. 7.	23. 10000, rem. 1.	24. 8666, rem. 6.
25. 3897, rem. 2.	26. 2456.	27. 3200.
28. 7070, rem. 7.	29. 2440, rem. [illegible]	30. 3004, rem. 8.
31. 1498, rem. 8.	32. 1947, rem. [illegible]	33. 200[illegible], rem. 4.
34. 169, rem. 29.	35. 11404, rem. [illegible]	36. 135, rem. 30.
37. 407, rem. 80.	38. 521, rem. 89.	39. 87, rem. 300.
40. 694, rem. 2.	41. 48, rem. 101.	42. 45, rem. 254.
43. 160, rem. 289.	44. 58, rem. 356.	45. 44, rem. 357.
46. 453, rem. 219.	47. 706, rem. 354.	48. 112, rem. 4543.
49. 234, rem. 641.	50. 3263, rem. 931.	51. 1017, rem. 2556.

52. 381, rem. 1664.	53. 2559, rem. 2316.
54. 6652, rem. 5423.	55. 114285, rem. 3351.
56. 1250, rem. 539.	57. 15200, rem. 10321.
58. 15005, rem. 54720.	59. 1338, rem. 110580.
60. 423297, rem. 37606.	61. 240100, rem. 117400.
62. 470, rem. 114903.	63. 63261, rem. 6731383.
64. 842532313, rem. 75.	65. 9886426883, rem. 672.
66. 567. 67. 36.	68. 528 times. 69. 13.
70. 229 times.	71. 30115. 72. 7674.
73. 375 rupees.	74. 256 days 75. 22.

Examples. 14.

1. 17280, rem. 1.	2. 26310.	3. 20089, rem. 2.
4. 2558, rem. 2.	5. 3842, rem. 5.	6. 14057, rem. 1.
7. 4320, rem. 7.	8. 2107, rem. 7.	9. 3456, rem. 7.
10. 58751, rem. 5.	11. 67253, rem. 4.	12. 10437, rem. 8.
13. 32198, rem. 10.	14. 49538, rem. 10.	15. 58491, rem. 6.

16. 228850, rem. 7. **17.** 455961, rem. 7. **18.** 649772, rem. 10.

19. (i) 1728394, rem. 1 ; 1152263 ; 864197, rem. 1 ; 691357, rem. 4 ; 576131, rem. 3 ; 493827 ; 432098, rem. 5 ; 384087, rem. 6 ; 345678, rem. 9 ; 314253, rem. 6 ; 288065, rem. 9 ; 265906, rem. 11 ; 246913, rem. 7 ; 230452, rem. 9 ; 216049, rem. 5 ; 203340, rem. 9 ; 192043, rem. 15 ; 181936, rem. 5 ; 172839, rem. 9.

(ii) 40352015 ; 26901343, rem. 1 ; 20176007, rem. 2 ; 16140806 ; 13450671, rem. 4 ; 11529147, rem. 1 ; 10088003, rem. 6 ; 8967114, rem. 4 ; 8070403 ; 7336730 ; 6725335, rem. 10 ; 6208002, rem. 4 ; 5764573, rem. 8 ; 5380268, rem. 10 ; 5044001, rem[illegible] 4747295, rem. 15 ; 4483557, rem. 4 ; 4247580, re[illegible] 4035201, rem. 10.

(iii) 493827160, rem. 1 ; 329218107 ; 246913580, rem. 1 ; 197530864, rem. 1 ; 164609053, rem. 3 ; 141093474, rem. 3 ; 123456790, rem. 1 ; 109739369 ; 98765432, rem. 1 ; 89786756, rem. 5 ; 82304526, rem. 9 ; 75973409, rem. 4 ; 70546737, rem. 3 ; 65843621, rem. 6 ; 61728395, rem. 1 ; 58097313 ; 54869684, rem. 9 ; 51981805, rem. 7 ; 49382716, rem. 1.

Examples. 15.

1.	210.	**2.**	465.	**3.**	1035.	**4.**	2850.
5.	5050.	**6.**	1254.	**7.**	3315.	**8.**	15150.
9.	245.	**10.**	44818.	**11.**	4568.	**12.**	37951.
13.	4628 and 3899.			**14.**	5444 and 4556.		

Examples. 16.

1.	17472.	**2.**	337050.	**3.**	672840.	**4.**	132624.
5.	244160.	**6.**	94976.	**7.**	2599400.	**8.**	601425.
9.	1233282.	**10.**	143472.	**11.**	446048.	**12.**	3532008.
13.	295100780.	**14.**	1220242681.	**15.**	3625.	**16.**	1645.
17.	4060.	**18.**	2100.	**19.**	418225.	**20.**	2300.
21.	12250.	**22.**	15625.	**23.**	25875.	**24.**	11088.
25.	281718.	**26.**	2039796.	**27.**	420158.	**28.**	4182640.
29.	8267512.	**30.**	36950.	**31.**	5565.	**32.**	31220.

33. 53175. **34.** 4560. **35.** 5917[illegible]. **36.** 1225.
37. 3025. **38.** 7396. **39.** 9409. **40.** 105625.
41. 216225. **42.** 606841. **43.** 802816.

Examples. 17.

1. 39. **2.** 23. **3.** 42. **4.** 68. **5.** 23.
6. 350, rem. 24. **7.** 540, rem. 40. **8.** 372, rem. 20.
9. 755, rem. 84. **10.** 677, rem. 117. **11.** 2935, rem. 168.
12. 12882, rem. 58. **13.** 359, rem. 319. **14.** 2057, rem. 294.
15. 1422, rem. 138. **16.** 389, rem. 4. **17.** 34, rem. 56.
18. 89, rem. 345. **19.** 827, rem. 46. **20.** 89, rem. 346.
21. 12, rem. 3456. **22.** 129, rem. 22. **23.** 157, rem. 42.
24. 123, rem. 67. **25.** 58, rem. 1368. **26.** 46, rem. 894.
27. 783, rem. 10743. **28.** 122, rem. 893. **29.** 9733, rem. 176.
30. 2716, rem. 187. **31.** 75, rem. 3. **32.** 937, rem. 4.
33. 255, rem. 1. **34.** 313, rem. 20. **35.** 3310, rem. 19.
36. 5515, rem. 17. **37.** 670, rem. 14. **38.** 1103, rem. 16.
39. 30, rem. 42. **40.** 24, rem. 14. **41.** 22, rem. [illegible].
42. 20, rem. 21. **43.** 16, rem. 34. **44.** 21, rem. 20.
45. 108, rem. 66.

Examples. 18.

1. 2195. **2.** 75582. **3.** 871882. **4.** 304166. **5.** 18776.
6. 85040. **7.** 1595. **8.** 8832. **9.** 92080. **10.** 45138.
11. 49, rem. 74. **12.** 188, rem. 53. **13.** 113, rem. 79[illegible].
14. 2012, rem. 284. **15.** 1064, rem. 3045. **16.** 866, rem. 25[illegible].

Examples. 19.

1. 2771928. **2.** 7386918. **3.** 3747321.
4. 94876320. **5.** 627399162. **6.** 222013980.
7. 153660000. **8.** 313199250. **9.** 6783119796.

Miscellaneous Examples. 20.

1. 2548 **2.** 2022. **3.** 8511. **4.** 621. **5.** 788.
6. 9001. **7.** 316. **8.** 11. **9.** 3791. **10.** 17.
11. 1477. **12.** 6354. **13.** 33794. **14.** 459801.

15. 40023 times, rem. 21. **16.** 532. **17.** 176. **18.** 34.
19. 150 ; 83. **20.** 7 times. **21.** 1545. **22.** 159943.
23. 89. **24.** 362. **25.** 514590. **26.** 99 and 106.
27. 23 years. **28.** 176913. **29.** 189461. **30.** 71265.
31. 615. **32.** 134807. **33.** 545 pice. **34.** 812168364.
35. 313288352. **36.** 475 rupees. **37.** *A*, 58 ; *B*, 34 ; *C*, 42.
38. *A*, 40 rupees ; *B*. 39 rupees ; *C*, 30 rupees. **39.** 135 rupees.
40. 18 per rupee. **41.** 60 seers ; 100 seers. **42.** 1800 rupees.
43. 5 years. **44.** 10 years ; 70 years **45.** 60. **46.** 3 P.M.

Examples. 21.

1. 624*a*. **2.** 1664*a*. **3.** 115328*a*. **4.** 59168*a*.
5. 121*a*. **6.** 372*a*. **7.** 604*a*. **8.** 830*a*.
9. 59328*p*. **10.** 142080*p*. **11.** 653184*p*. **12.** 38700*p*
13. 21624*p*. **14.** 135324*p*. **15.** 5187*p*. **16.** 7641*p*.
17. 13055*p*. **18.** 194 pice ; 582*p*. **19.** 501 pice ; 1503*p*.
20. 635 pice ; 1905*p*. **21.** 7410. **22.** 1632. **23.** 631.
24. 100. **25.** 3896. **26.** 482. **27.** 14400*s*.
28. 4800*s*. **29.** 14180*s*. **30.** 6100*s*. **31.** 405*s*.
32. 532*s*. **33.** 617*s*. **34.** 719*s*. **35.** 8400*d*.
36. 160800*d*. **37.** 1684800*d*. **38.** 10932*d*. **39.** 12156*d*.
40. 18420*d*. **41.** 870*d*. **42.** 2170*d*. **43.** 1883*d*. **44.** 960000*q*.
45. 293616*q*. **46.** 7352*q*. **47.** 3229*q*. **48.** 6758*q*.
49. 2691*q*. **50.** 37 crowns ; 370 sixpences ; 555 fourpences.
51. 42 crowns ; 420 sixpences ; 630 fourpences.
52. 63 crowns ; 630 sixpences ; 945 fourpences.
53. 19 half-crowns. **54.** 255 threepences. **55.** 36000*q*.
56. 28224 half-pence. **57.** 100 oranges. **58.** 2286 farthings.
59. 125 books. **60.** 55 children. **61.** 396 beggars.

Examples. 22.

1. R52. 1*a*. 4*p*. **2.** R160. 6*a*. 1*p*. **3.** R405. 1*a*. 5*p*.
4. R20. 9*a*. **5.** R40. 11*a*. 11*p*. **6.** R57. 13*a*. 11*p*.
7. R157. 13*a*. 3*p*. **8.** R247. 4*a*. 2*p*. **9.** R52. 1*a*. 5*p*.
10. R15. 10*a*. **11.** R59. 2*a*. 3*p*. **12.** R48. 2*a*. 6*p*.
13. R55. 5*a*. 3*p*. **14.** R69. 13*a*. **15.** R120.

16.	£1. 11s. 4d.	17.	£29. 5s. 3d.	18.	£37. 3s. 4d.
19.	£1. 0s. 10d.	20.	£10. 8s. 6d.	21.	£3. 9s. 5¾d.
22.	£8. 7s. 6d.	23.	£8. 5s. 2¼d.	24.	£4. 11s. 10d.
25.	15s. 9½d.	26.	£49 5s.	27.	£28. 7s.
28.	£48. 15s.	29.	£9. 18s.	30.	£40. 10s.
31.	R15.	32.	R4. 11a.	33.	15s.

Examples. 23.

1.	R1. 11a. 2 pice.	2.	R2, 14a. 1 pice.	3.	R3. 1a. 1 pice.
4.	R2. 9a. 2 pice.	5.	R2. 9a.	6.	R2. 15a.
7.	R3. 0a. 3p.	8.	R2. 14a. 6p.	9.	R52. 12a. 9p.
10.	R85. 12a. 10p.	11.	R82. 9a.	12.	R518. 2a.
13.	R1888.	14.	R1380. 11a. 4p.	15.	R1973. 14a. 7p.
16.	R4657. 1a. 5p.	17.	R17776. 6a. 10p.	18.	R23930. 10a. 1p.
19.	R23805. 12a. 7p.	20.	R22221. 3a. 6p.	21.	£509. 1s. 5d.
22.	£470. 19s.	23.	£1010. 5s. 9d.	24.	£10103. 0s. 8¼d.
25.	£5746. 19s. 9½d.	26.	£465. 12s. 3½d.	27.	£877. 17s. 5½d.
28.	£850. 6s. 4½d.	29.	£1758. 17s. 2¾d.		

Examples. 24.

1.	R6. 3a. 1 pice.	2.	R1. 12a. 3 pice.	3.	R9. 10a. 3 pice.
4.	R3. 11a. 9p.	5.	R39. 14a. 9p.	6.	R9. 8a. 4p.
7.	R15. 3a. 5p.	8.	13a. 9p.	9.	R10. 8a. 10p.
10.	R58. 3a 8p.	11.	R273. 13a. 11p.	12.	6a. 6p.
13.	£5. 9s. 7d.	14.	£13. 15s. 8¾d.	15.	£20. 18s. 8¾d.
16.	£2. 12s. 4½d.	17.	£2. 3s. 3¾d.	18.	£11. 12s. 8¾d.
19.	£7. 15s. 1¾d.	20.	£2. 7s. 1½d.	21.	£30. 14s. 9½d.
22.	£809. 6s. 9¾d.	23.	£467. 4s. 11¼d.	24.	£118. 18s. 5¾d.

Examples. 25.

1. R10. 10a. 1 pice ; R17. 11a. 3 pice ; R24. 13a. 1 pice.
2. R48. 14a. 6p. ; R68. 7a. 6p. ; R88. 0a. 6p.
3. R439. 4a. 1p. ; R519. 1a. 11p. ; R638. 14a. 8p.
4. £89. 16s. 3d. ; £209. 11s. 3d. ; £269. 8s. 9d.
5. £226. 12s. 4½d. ; £302. 3s. 2d. ; £491. 0s. 1¾d.

6. £201. 19s. 4½d.; £363. 10s. 10½d.; £484. 14s. 6d.
7. R47. 14a. 2 pice; R73; R57. 0a. 2 pice.
8. R2228. 10a.; R3939. 14a. 3p.; R3979. 11a.
9. R6106. 12a. 4p.; R5911. 5a. 8p.; R7035.
10. £2819. 19s. 7½d.; £2228. 2s. 8d.; £27851. 13s. 4d.
11. £4816. 13s. 2¼d.; £3503. 0s. 6d.; £20434. 6s. 3d.
12. R1. 14a. 13. R126. 14. £16. 2s. 6d. 15. £37. 14s. 2d.
16. R5468. 12a. 17. £266. 17s. 6d. 18. R10031. 4a.

Examples. 26.

1. R75. 7a. 2 pice; R121. 6a. 2 pice.
2. R288. 7a. 9p.; R366. 7a. 3p. 3. R1618. 3a. 6p.; R2706.
4. R6015. 3a. 9p. R8490. 7a. 6p. 5. £2235. 12s. 6d.; £490.
6. £12763. 10s. 6d.; £4285. 13s. 9½d.
7. £4934. 10s. 0¾d.; £5432. 10s. 9¾d.
8. £7783. 18s. 10½d.; £8624. 13s. 10½d.
9. R2754. 9a. 9p. 10. R1799. 12a. 9p.

Examples. 27.

1. R3. 2a. 1 pice. 2. R4. 13a. 3 pice. 3. R7. 7a. 7p.
4. R10. 12a. 4p. 5. R12. 13a. 1p. 6. R5. 15a. 3p.
7. R15. 5a. 3p. 8. R10. 1a. 11p. 9. £3. 7s. 2½d.
10. 11s. 3¼d. 11. £55. 12s. 9¼d. 12. £53. 18s. 7¾d.
13. £3. 7s. 10½d. 14. £2. 7s. 1½d. 15. R6. 15a. 10p.
16. R56. 7a. 5p. 17. R145. 12a. 6p. 18. R143. 15a. 2p.
19. R41. 3a. 5p. 20. R138. 2a. 8p. 21. £9. 15s. 10½d.
22. £55. 13s. 2½d. 23. £47. 7s. 1¼d. 24. £420. 2s. 3¾d.
25. R1. 2a. 5p. 26. R3. 4a. 3p. 27. R5. 12a. 4p.
28. R12. 10a. 5p. 29. £125. 15s. 9¼d. 30. £12. 18s. 10d.
31. 3a. 9p. 32. 10 annas. 33. 2a. 8p. 34. 3s 6d.

Examples. 28.

1. R13. 9a. 3p. 2. R37. 9a. 10p. 3. R2. 12a. 9p.
4. R11. 7a. 4p. 5. R40. 10a. 10p. 6. R61. 0a. 1p.
7. 3a. 3p. 8. R2. 2a. 2p. 9. £43. 16s. 8d.
10. £22. 15s. 8d. 11. £5. 2s. 2¾d. 12. £3 0s. 1¾d.

Examples. 29.

1. R5. 1*a*. 1*p*. 2. R4. 15*a*. 7*p*. or 8*p*. 3. R1. 10*a*. 6*p*.
4. R3. 4*a*. 5*p*. 5. R7. 10*a*. 2*p*. 6. R3. 15*a*. 2*p*.
7. R10. 13*a*. 10*p*. 8. R9. 3*a*. 10*p*. 9. £5. 11*s*. $6\frac{3}{4}$*d*.
10. £4. 5*s*. 10*d*. 11. £11. 10*s*. $3\frac{3}{4}$*d*. 12. £4. 19*s*. 9*d*.
13. £2. 13*s*. $1\frac{1}{2}$*d*. 14. £2. 18*s*. $5\frac{1}{4}$*d*.
15. R204. 11*a*, rem. 8*p*. 16. R143. 8*a*. 9*p*., rem. 38*p*.
17. R65. 8*a*. 3*p*., rem. 15*p*. 18. R98. 12*a*. 2*p*., rem. 989*p*.
19. £14. 10*s*. 6*d*., rem. 6*d*. 20. £127. 15*s*. 2*d*., rem. 230*d*.

Examples. 30.

1. 9. 2. 15. 3. 24. 4. 21. 5.
6. 28, rem. R2. 11*a*. 6*p*. 7. 21, rem. R3. 7*a*. 4*p*.
8. 40, rem. R3. 1*a*. 9*p*. 9. 32, rem. £18. 3*s*. 3*d*.
10. 102, rem. £8. 3*s*. $4\frac{1}{2}$*d*. 11. 57. 12. 184.
13. 300. 14. 3426. 15. 7 days. 16. 100

Examples. 31.

1. 1192320 gr. 2. 170880 gr. 3. 21927 gr.
4. 165000 gr. 5. 319896 gr. 6. 41865 gr.
7. 1 lb. 4 oz. 6 dwt. 21 gr. 8. 1 lb. 6 oz. 11 dwt. 19 gr.
9. 10 lb. 0 oz. 12 dwt. 4 gr. 10. 17 lb. 4 oz. 6 dwt. 16 gr.
11. 2 lb. 3 oz. 0 dwt. 23 gr. 12. 3 lb. 0 oz. 9 dwt. 9 gr.
13. 24 lb. 6 oz. 8 dwt. 13 gr. 14. 2 oz. 16 dwt. 22 gr.
15. 2 lb. 6 oz. 14 dwt. 8 gr.
16. 1 lb. 4 oz. 8 dwt. 8 gr. ; 8 lb. 9 oz. 1 dwt. 8 gr. ;
116 lb. 9 oz. 19 dwt. 16 gr.
17. 8 oz 6 dwt. 16 gr. ; 20. 18. 4 lb. 9 oz.
19. 3 dwt. 18 gr. 20. 34.

Examples. 32.

1. 4386816 dr. 2. 1218560 dr. 3. 2005392 dr.
4. 5361664 dr. 5. 1240064 dr. 6. 84156 dr.
7. 1 ton. 14 cwt. 3 qr. 14 lb. 3 oz. 15 dr.
8. 4 cwt. 1 qr. 6 lb. 4 oz. 9. 12 lb. 6000 gr.

10. 63775 tons 10 cwt. 0 qr. 22 lb. 6000 gr.

11. 38 lb. 1 oz. 6 dr. **12.** 14 cwt. 3 qr. 26 lb. 8 oz.

13. 11 tons 9 cwt. 3 qr. 4 lb. **14.** 3 lb. 4 oz. 6 dr.

15. 6 tons 8 cwt. 2 qr. 18 lb.

16. 2 tons 15 cwt. 0 qr. 3 lb. 15 oz. 14 dr.; 34 tons 11 cwt. 3 qr. 14 lb. 3 oz.; 129 tons 6 cwt. 2 qr. 19 lb. 10 oz. 2 dr.

17. 1 cwt. 2 qr. 27 lb. 5 oz.; 500.

18. 2 tons 1 cwt. 3 qr. 11 lb 8 oz. **19.** 2 cwt. 2 qr. 2 lb.

20. 768. **21.** A pound of feathers is heavier by 1240 grains.

22. 175 lb. Troy.

Examples. 33.

1. 8140 kanchas; 10175 tolas. **2.** 6448 kanchas; 8060 tolas.

3. 4796 kanchas; 5995 tolas. **4.** 6176 kanchas; 7720 tolas.

5. 2288 kanchas; 2860 tolas. **6.** 7040 kanchas; 8800 tolas.

7. 1 md. 32 seers 14 ch. **8.** 1 md. 12 seers 1 ch. 1 kancha.

9. 12 md. 18 seers 3 ch. **10.** 31 md. 10 seers.

11. 31 md. 13 seers 13 ch. **12.** 41 md. 13 seers 7 ch.

13. 81 md. 12 seers 1 ch. 1 knacha. **14.** 4 md. 27 seers 13 ch.

15. 7 md. 31 seers 10 ch. 2 kanchas.

16. 1 md. 11 seers 0 ch 3 kanchas; 5 md. 38 seers 3 ch. 2 kanchas; 305 md. 11 seers 8 ch. 3 kanchas.

17. 39 seers 1 ch.; 25. **18.** 595 md. 2 seers 3 ch.

19. 1 seer 2 kanchas. **20.** 640. **21.** 18900. **22.** 75

Examples. 34.

1. 20 tolas. **2.** 2280 tolas. **3.** 3816 tolas.

4. 6792 tolas. **5.** 45120 tolas. **6.** 72600 tolas.

7. 5 can. 7 md. 1 seer. **8.** 16 md. 1 viss 2 seers 6 poll.

9. 3 can. 12 md. 7 viss 1 seer 5 poll. 1 tola.

10. 4 can. 16 md. 3 viss 2 seers 2 poll. 2 tolas.

11. 2 viss 2 seers 4 poll. **12.** 1 can. 8 md. 7 viss.

13. 86 can. 5 md. **14.** 4 md. 3 viss 3 seers 6 poll.

15. 11 can. 14 md. 1 viss 1 seer 6 poll.

16. 1 can. 3 md. 2 viss 2 seers 6 poll.; 11 can. 19 md. 6 viss 4 seers; 38 can. 9 md. 4 viss 6 poll.

17. 12 md. 4 viss ; 40. **18.** 15 can. 13 md. 1 viss 24 poll.
19. 1 md. 1 viss 1 seer 1 poll. **20.** 960. **21.** 4375.

Examples. 35.

1. 73728000 dhans. **2.** 801792 dhans. **3.** 756608 dhans.
4. 23224320 dhans. **5.** 31488 dhans. **6.** 1257984 dhans
7. 1 can. 33 seers 24 tanks. **8.** 1 can. 7 md. 12 seers 1 tank.
9. 18 md. 39 seers 39 tanks 2 mashas.
10. 135633 can. 13 md. 24 seers 32 tanks.
11. 2 md 3 seers 22 tanks 2 mashas.
12. 2 can. 5 md. 37 seers 61 tanks.
13 12 can. 3 md. 14 seers 36 tanks.
14. 3 can. 3 md. 32 seers 59 tanks.
15. 7 can. 8 md. 10 seers 3 tanks.
16. 16 md. 36 seers 53 tanks ; 6 can. 1 md. 32 seers 56 tanks ; 39 can 1 md. 25 seers 15 tanks.
17. 3 md. 32 seers 56 tanks ; 400. **18.** 18 can. 8 md. 9 seers.
19. 1 md 1 seer 1 tank. **20.** 6400.

Examples. 36.

1. 4500 in. **2.** 39600 in. **3.** 190080 in. **4.** 380160 in.
5. 182556 in. **6.** 209880 in. **7.** 612018 in. **8.** 762 in.
9. 1110 in. **10.** 1467 in. **11.** 184878 in. **12.** 431766 in.
13. 28 po. 2 yd. **14.** 36 po. 4 yd. **15** 19 po. 2 yd. 1 ft. 6 in.
16. 35 po. 3 yd. 1 ft. 6 in. **17.** 6 po. 1 yd. 10 in.
18. 1 mi. 36 po. 5 yd. 1 ft. **19.** 1 mi. 1 fur. 9 po. 4 yd. 6 in.
20. 1 mi. 2 fur. 4 po. 2 ft. 5 in. **21.** 5 po. 10 in.
22. 1 mi. 7 fur. 6 po. 1 ft. **23.** 3 mi. 5 fur. 24 po. 3 yd. 2 ft. 3 in.
24. 15 mi. 4 fur. 28 po. 2 ft. 6 in. **25.** 504 in. **26.** 63 in.
27. 126 in. **28.** 100 nails. **29.** 44 nails. **30.** 50 ells. **31.** 8000.

Examples. 37.

1. 29808 sq. in. **2.** 4704480 sq. in. **3.** 7527168800 sq. in.
4. 8028979200 sq. in. **5.** 47358432 sq. in. **6.** 80760240 sq. in.
7. 7880004 sq. in. **8.** 127692 sq. in. **9.** 200196 sq. in.
10. 300384 sq. in. **11.** 17546220 sq. in. **12.** 22632732 sq. in.

13. 12 sq. po. 2 yd. **14.** 24 sq. po. 14 yd. **15.** 32 sq. po. 3 yd.
16. 33 sq. po. 1 yd. 6 ft. 108 in.
17. 1 ac. 2 ro. 18 po. 19 yd. 4 ft. 72 in.
18. 7 ac. 3 ro. 10 po. 8 yd. 4 ft. 72 in.
19. 2 ac. 23 po. 8 yd. 2 ft. 36 in.
20. 2 ac. 2 po. 25 yd. 3 ft. 72 in.
21. 5 sq. yd. 5 ft. 34 in. **22.** 2 sq. po. 3 ft. 94 in.
23. 25 sq. po. 5 yd. 7 ft. 62 in. **24.** 1 ac. 2 ro. 11 po. 28 yd. 51 in.
25. 4390848 sq. in. **26.** 48400 sq. yd.

Examples. 38.

1. 23280 ga. **2.** 4025 ga. **3.** 42140 ga. **4.** 124000 ga.
5. 6399 ga. **6.** 101100 ga. **7.** 1 bi. 6 cot. 15 ch.
8. 2 cot. 4 ch. 8 ga. **9.** 1 bi. 4 cot. 10 ch. 12 ga.
10. 1 bi 11 cot. 4 ch.

Examples. 39.

1. 139968 cu. in.; 326592 cu. in.; 559872 cu. in.; 746496 cu. in.; 933120 cu. in.; 1819584 cu. in.
2. 2 cu. yd. 17 ft. 768 in.; 21 cu. yd. 4 ft. 966 in.

Examples. 40.

1. 404 gills. **2.** 2816 gills. **3.** 1504 gills. **4.** 1696 gills.
5. 9344 gills. **6.** 18176 gills. **7.** 159744 gills. **8.** 50432 gills.
9. 428032 gills. **10.** 31 gall. 1 qt.
11. 1 barrel 28 gall. 3 qt. 1 gill. **12.** 2 barrels 34 gall. 1 qt.
13. 6 barrels 9 gall. 3 qt. 1 gill. **14.** 1 qr. 3 bus. 2 pk. 1 gall. 3 qt.
15. 5 bus. 3 pk. 3 qt. 1 pt. **16.** 1 last 2 qr. 1 bus. 2 pk. 1 gall. 1 qt.
17. 4 lasts 1 ld. 3 qr. 1 bus. 3 pk. 1 qt. 1 pt. 1 gill.
18. 25 lb. avoir. **19.** 3500 lb. avoir. **20.** 64; 32.

Examples. 41.

1. 25925 sec. **2.** 637800 sec. **3.** 1512000 sec.
4. 1 hr. 23 min. 20 sec. **5.** 1 da. 3 hr. 26 min. 5 sec.
6. 1 da. 3 hr. 46 min. 40 sec. **7.** 1 wk. 4 da. 13 hr. 46 min. 40 sec.
8. 94. **9.** 121. **10.** 244. **11.** 577.
12. 289. **13.** 821. **14.** Thursday. **15.** Wednesday.

Examples. 42.

1. 26247″. 2. 865535″. 3. 1296000″.
4. 1°. 6′. 40″. 5. 10°. 32′. 36″. 6. 1 rt. gle. 26°. 40′.
7. 1 rt. gle. 47°. 36′. 8. 3 rt. gle. 4°. 20′. 54″.

Examples. 43.

1. 24000. 2. 104 reams 3 quires 8 sheets. 3. 432.

Examples. 44

1. 1120 gr. 2. 1632 gr 3. 24960 m.
4. 192000 m. 5. 612309 m.

Miscellaneous Examples. 45.

1. 61200. 2. R19. 13*a* 6*p*. 3. £569 1*s*. 7½*d*.
4. 479 mi. 2 fur. 5. R13. 3*a*. 6 2028.
7. 1*a*. 4*p*. 8. 1*s*. 9¾*d*. 9. 16384. 10. 105 parcels, 30 seers rem.
11. 96. 12. 1920. 13. 11. 14. R188 11*a* 9*p*.
15. R12. 15*a*. 6*p*. 16. R48. 14*a*. 9*p*. ; R343. 6*a*. 3*p*.
17. R2. 10*a*. 3*p*. 18. R500. 13*a* 9*p* 19. £1. 1*s* 11*d*.
20. R5. 1*a*. 21. R3754. 9*a*. 9*p*. 22. 6*s*. 3*d*.
23. 56 yr. 3 mo. 7 da. 24. 160. 25. 5 sec.
26. 3960. 27. 2 ft. 7 in 28. 4195. 29. R83. 12*a*.
30. R32. 11*a*. 9*p*. 31. £66. 12*s*. 6*d* 32 17. 33. R687. 10*a*.
34. £30. 5*s*. 1½*d*. 35. £66. 13*s*. 4*d*. 36. 104. 37. 53.
38. 130 lb. 39. 16 yr. 4 mo. 2 da. 40. 4*s*. 2*d*. 41. 2*s* 6*d*.
42. 62. 43. 12 seers. 44. 5 md 45. 8 min. 18 sec.
46. 5 ft. 4 in. 47. 16th September. 48. Friday the 8th of May.
49. 53 hours. 50. 192000 miles per sec. 51. 68. 52. 19.
53. 3 yd. 54. R2. 3*a*. 55. 11088. 56. 4497 times.
57. 18000. 58. R2745. 59. 41 yd. 4 in. 60. 28 yr. 13 wk. 4 da.

Examples. 46

1. 84. 2. 44. 3. 5*a*.
4. Receives £13. 13*s*. 9*d*. 5. R1. 7*a*. 3*p*.

Examples. 47.

1. Gains R2. 8a. 2. R21. 1a. 6p. 3. R30. 4. R7. 12a.
5. R30. 7a. 6p. 6. R1. 10a. 3p. 7. 3p. 8. 4d.
9. £1 1s. 10. 21 qr. 11. 8s. 4d. per yard.
12. R1. 5a per lb 13. Gain 12s. 6d. 14. 4d.
15. (i) R1. 2a. ; (ii) R1. 3a.

Examples. 48.

1. 4a. 2p. 2. £1. 4s. 3. 15a. 4. R9. 6a. 5. 2s. 3d.
6. 2s 3d. 7. 2d. 8. 6 seers. 9. 9 lb. 10. 2s. 6d.

Examples. 49.

1. A, R23. 6a ; B, R16 1a. 9p.
2. A, £12. 6s 7½d ; B, £16. 0s. 10½d.
3. The two get R31. 3a 1p. each ; the rest R22. 4a. 4p. each.
4. Each man, R20. 4a 6p ; each woman, R26. 4a. 6p.
5. A, R16. 6a. 10p. ; B R13. 6a. 10p. ; C, R9. 6a. 10p.
6. A, R113. 13a. 3p. ; B, R106 13a. 3p. ; C, R108. 13a. 3p.
7. £40.

Examples. 50.

1. Boy, R10. 6a. 4p ; girl, R5. 3a. 2p.
2. A's share = R15. 9a. 6p. ; B's = R10. 6a. 4p. ; C's = R5. 3a. 2p.
3. Each man, R12. 8a. ; each woman, R6. 4a. ; each boy, R3 2a.
4. A, £6. 14s 6d ; B, £3. 7s. 3d. ; C, £1. 13s. 7½d.
5. One gets £5. 3s 9d ; and the other two, £2. 11s. 10½d each.
6. A, R26. 15a. 3p. ; B, R12. 8a. 6p.

Examples. 51.

1. 12. 2. 10 3. 12. 4. 16.
5. 11 rupees, 22 half-rupees, 44 quarter-rupees. 6. 32.

Examples. 52.

1. R3. 7a. 9p. 2. R10. 2a.
3. The price of a horse is R75. 8a, of a cow, R25. 8a. and of a sheep, R5 8a.
4. A mark = 11¾d. ; a gulden = 1s. 11¾d. ; a rouble = 3s. 1½d.
5. R38. 4a. 6p.

Examples. 33.

1. 2, 3. 2. 3, 5, 9. 3. 2, 3, 4, 9. 4. 2, 3, 4, 5, 10.
5. 2, 3, 4, 11. 6. 2, 11. 7. 2, 3, 5, 10. 8. 2, 4.
9. None. 10. 5. 11. 2, 3, 4, 8, 11. 12. 2, 3, 4, 8, 9, 11.
13. 3, 5. 14. 5. 15. 2, 4, 5, 8, 10. 16. 2, 4, 5, 8, 10.
17. 3, 9. 18. 3, 11. 19. 2, 3. 20. 2, 3, 5, 9, 10.
21. 7. 22. 11. 23. 13. 24. 7, 11, 13.
25. 11. 26. 7, 13. 27. None. 28. 7, 11, 13.
29. 6, 12. 30. 6, 12. 31. 6, 12, 30. 32. None.
33. 2; 1. 34. 1; 7; 2. 35. 2717.

Examples. 34.

1. 2^3. 2. $2^2.3$. 3. 2.3^2. 4. $2^3.3$. 5. 3^3.
6. 2^5. 7. $2^4.3$. 8. 2.5^2. 9. $3^2.7$. 10. 2^6.
11. $2^4.5$. 12. $2^3.11$. 13. $3^2.11$. 14. $2^2.5^2$. 15. $2^2.5^3$.
16. $2^4.11$. 17. $3^2.13$. 18. $2^5.3^2$. 19. $5^2.11$. 20. 5^4.
21. $3^3.37$. 22. $2.3.5^2.7$. 23. $2^4.3^4$. 24. $2^5.11$. 25. $2^4.5^3$.
26. $2.5^2.73$. 27. $2^7.3^2.5$. 28. $3^2.7.13$. 29. $2^9.5^3$.
30. $2^2.3.5^2.23.29$. 31. prime. 32. prime. 33. 3^4.
34. prime. 35. prime. 36. prime. 37. prime. 38. $5^2.23$.
39. prime. 40. prime. 41. $11^2.31$. 42. 3.13^2. 43. 17.269.
44. prime. 45. 23.31. 46. prime. 47. 13.503. 48. 11.631.
49. prime. 50. 29.47. 51. 10. 52. 11. 53. 11.
54. 5, 7. 55. 5, 7. 56. 6, 8, 12, 24.

Examples. 35.

1. 3. 2. 4. 3. 5. 4. 18. 5. 5. 6. 12.
7. 75. 8. 4. 9. 24. 10. 5. 11. 4.
12. No common factor. 13. 56. 14. 25. 15. 28.

Examples. 36.

1. 48. 2. 2. 3. 4. 4. 17. 5. 29. 6. 124.
7. 101. 8. 143. 9. 377. 10. 7. 11. 133. 12. 25.
13. 19. 14. 15. 15. 53. 16. 28. 17. 39. 18. 113.
19. 173. 20. 147. 21. 221. 22. 3. 23. 57. 24. 287.
25. 213. 26. 221. 27. 15. 28. 1534. 29. 257. 30. 6.

31. No. 32. Yes. 33. No. 34. Yes. 35. No. 36. No.
37. Yes. 38. Yes. 39. No. 40. 37. 41. 37. 42. 23.
43. 17. 44. 3. 45. 5. 46. 3. 47. 63. 48. 17.
49. 57. 50. 2. 51. 2. 52. R1. 4*a*. 53. 3*d*.
54. 16. 55. 32. 56. No. 57. 180 gall. 58. ·1 tola.

Examples. 57.

1. 96. 2. 3724. 3. 891. 4. 3520. 5. 7488.
6. 259488. 7. 672. 8. 23374. 9. 87087.
10. 759655. 11. 49077. 12. 734877. 13. 96672.
14. 159137. 15. 18345. 16. 2672700. 17. 2310.
18. 2376. 19. R5256. 12*a*. 20. 64. 21. 390.

Examples. 58.

1. 48. 2. 48 3. 720. 4. 36. 5. 2520.
6. 1680 7. 28050. 8. 360. 9. 1890. 10. 7560.
11. 7200. 12. 144. 13. 8415. 14. 7920. 15. 792.
16. 3570. 17. 228150. 18. 98280. 19. 49140. 20. 5481.
21. 237510. 22 2520. 23. 1680. 24. 10800.
25. 98280. 26. 189. 27. 389. 28. 141.
29. 1296 sq. in. 30. £189. 31. 14 min. 32. 90 miles.
33. 131 yd. 9 in. 34. 677. 35. 232792560. 36. 75 yards.

Examples. 59.

1. 4*a*. 2. 4*s*. 3. 2*q*. 4. 1 seer. 5. 5*a*. 6. 9*s*.
7. 7 in. 8. 5*p*. 9. 10 in. 10. 4*d*. 11. 3 pice.
12. 3 cwt. 13. 160 yd. 14. 6 ch. 15. 9 sq. in. 16. 7 lb.
17. 6*a*. 18. 9*a*. 19. 1 ft. 20. 4*d*. 21. 15 min.

Examples. 60.

1. $\frac{18}{9}$; $\frac{45}{9}$; $\frac{63}{9}$; $\frac{99}{9}$. 2. $\frac{22}{2}$; $\frac{99}{9}$; $\frac{121}{11}$; $\frac{275}{25}$; $\frac{385}{35}$.
3. $\frac{105}{5}$; $\frac{684}{9}$; $\frac{11925}{75}$. 4. $\frac{10}{12}$; $\frac{15}{18}$; $\frac{60}{72}$; $\frac{500}{600}$; $\frac{48}{12}$; [illegible]; $\frac{330}{[illegible]}$; $\frac{2100}{600}$.
5. $\frac{30}{90}$; $\frac{54}{90}$; $\frac{72}{90}$; $\frac{14}{90}$; $\frac{36}{90}$. 6. $\frac{2}{11}$; $\frac{3}{5}$; $\frac{6}{10}$. 7. [illegible]; $\frac{5}{6}$; $\frac{5}{6}$; $\frac{7}{6}$.

Examples. 61.

1. $\frac{1}{2}$. 2. $\frac{1}{3}$. 3. $\frac{1}{2}$. 4. $\frac{3}{4}$ 5. $\frac{5}{8}$.
6. $\frac{1}{6}$. 7. $\frac{3}{4}$ 8. $\frac{2}{3}$. 9. $\frac{2}{3}$. 10. $\frac{1}{5}$.

11. $\frac{4}{5}$. 12. $\frac{7}{8}$. 13. $\frac{3}{8}$. 14. $\frac{3}{4}$. 15. $\frac{3}{4}$.
16. $\frac{1}{3}$. 17. $\frac{1}{3}$. 18. $\frac{3}{4}$. 19. $\frac{4}{25}$. 20. $\frac{2}{5}$.

Examples. 61a.

1. $\frac{2}{3}$ 2. $\frac{4}{9}$. 3. $\frac{9}{10}$. 4. $\frac{2}{15}$. 5 $\frac{3}{5}$. 6. $\frac{1}{2}$.
7. $\frac{10}{21}$ 8. $\frac{7}{15}$. 9. $\frac{7}{9}$. 10. $\frac{5}{9}$. 11. $\frac{7}{8}$. 12. $\frac{5}{6}$.
13 $\frac{9}{22}$. 14. $\frac{5}{11}$. 15. $\frac{23}{43}$. 16. $\frac{119}{117}$. 17. $\frac{561}{940}$. 18. $\frac{11}{16}$.
19. $\frac{159}{196}$. 20 $\frac{60}{77}$. 21. $\frac{13}{17}$. 22. $\frac{2}{3}$. 23. $\frac{11}{13}$ 24. $\frac{17}{31}$.
25 $\frac{103}{136}$ 26. $\frac{29}{37}$. 27. $\frac{3}{4}$. 28. $\frac{603}{64}$. 29. $\frac{23}{67}$. 30. $\frac{80}{141}$
31. $\frac{43}{54}$. 32. $\frac{2}{7}$ 33. $\frac{78}{89}$. 34. $\frac{5}{7}$. 35. $\frac{11}{18}$.

Examples 61b.

1. $\frac{1}{6}$. 2. $\frac{5}{8}$. 3. $\frac{4}{9}$. 4. $\frac{3}{2}$. 5. $\frac{4}{15}$. 6 $\frac{1}{14}$.
7. $\frac{1}{12}$. 8. $\frac{91}{170}$. 9 $\frac{7}{8}$ 10. $\frac{34}{5}$. 11. $\frac{1}{18}$. 12. $\frac{6}{7}$.

Examples 62.

1. $\frac{10}{3}$. 2 $\frac{37}{6}$. 3. $\frac{102}{11}$. 4. $\frac{87}{10}$. 5. $\frac{20}{3}$.
6. $\frac{701}{100}$. 7. $\frac{843}{70}$. 8. $\frac{403}{20}$. 9. $\frac{1601}{41}$. 10. $\frac{2101}{90}$.
11. $\frac{5807}{900}$. 12. $\frac{7301}{90}$. 13. $\frac{648}{25}$. 14. $\frac{12421}{111}$. 15. $\frac{2811}{99}$.
16. $\frac{741}{100}$. 17. $\frac{9321}{1000}$. 18 $\frac{2255}{101}$. 19. $\frac{8044}{201}$. 20. $\frac{400}{99}$.

Examples. 63.

1. $3\frac{1}{2}$. 2. $2\frac{1}{4}$. 3. $4\frac{1}{3}$. 4. $5\frac{1}{4}$. 5. $3\frac{2}{7}$.
6. $3\frac{3}{4}$. 7. 9. 8. $6\frac{1}{3}$. 9. $9\frac{9}{10}$. 10. 5.
11. $2\frac{1}{14}$. 12. 4 13. $3\frac{3}{4}$ 14. $4\frac{12}{17}$. 15. $3\frac{13}{16}$.
16. $4\frac{2}{7}$. 17. $2\frac{29}{301}$. 18. $7\frac{1}{11}$. 19. $56\frac{2}{3}$. 20. 7.
21. 25[illegible]. 22. 329. 23. $101\frac{1}{3}$. 24. 10. 25. $48\frac{7}{9}$.
26. $2\frac{1}{3}$. 27. $11\frac{201}{425}$. 28. $10\frac{4}{129}$. 29. 11. 30. $4\frac{392}{577}$.

Examples. 64.

1. $\frac{4}{12}, \frac{10}{12}$. 2. $\frac{9}{30}, \frac{8}{30}$. 3. $\frac{35}{80}, \frac{18}{80}$. 4. $\frac{6}{12}, \frac{4}{12}, \frac{3}{12}$.
5. $\frac{40}{60}, \frac{45}{60}, \frac{48}{60}$. 6. $\frac{140}{168}, \frac{144}{168}, \frac{147}{168}$. 7. $\frac{27}{72}, \frac{56}{72}, \frac{30}{72}$. 8. $\frac{24}{60}, \frac{35}{60}, \frac{42}{60}$.
9. $\frac{75}{240}, \frac{70}{240}, \frac{66}{240}$. 10. $\frac{40}{300}, \frac{45}{300}, \frac{2}{300}$. 11. $\frac{126}{300}, \frac{35}{300}, \frac{270}{300}$.
12. $\frac{36}{900}, \frac{40}{900}, \frac{44}{900}$. 13. $\frac{40}{12}, \frac{51}{12}, \frac{74}{12}$. 14. $\frac{48}{24}, \frac{4}{24}, \frac{3}{24}$.
15. $\frac{36}{12}, \frac{60}{12}, \frac{7}{12}$. 16. $\frac{15}{105}, \frac{350}{105}, \frac{210}{105}, \frac{63}{105}$. 17. $\frac{36}{12}, \frac{4}{12}, \frac{48}{12}, \frac{8}{12}$.
18. $\frac{30}{60}, \frac{20}{60}, \frac{15}{60}, \frac{12}{60}, \frac{10}{60}$. 19. $\frac{14}{154}, \frac{21}{154}, \frac{8}{154}, \frac{33}{154}, \frac{154}{154}$.
20. $\frac{1155}{3465}, \frac{3070}{3465}, \frac{2475}{3465}, \frac{2695}{3465}, \frac{3885}{3465}$. 21. $\frac{730}{600}, \frac{440}{600}, \frac{385}{600}, \frac{485}{600}, \frac{703}{600}$.

22. $\frac{288}{144}, \frac{336}{144}, \frac{84}{144}, \frac{64}{144}, \frac{99}{144}$.
23. $\frac{210}{2400}, \frac{150}{2400}, \frac{40}{2400}, \frac{775}{2400}, \frac{24}{2400}$.
24. $\frac{96}{48}, \frac{160}{48}, \frac{348}{48}, \frac{15}{48}, \frac{16}{48}$.
25. $\frac{6720}{8120}, \frac{240}{8120}, \frac{72}{8120}, \frac{714}{8120}, \frac{168}{8120}$.
26. $\frac{72}{24}, \frac{180}{24}, \frac{56}{24}, \frac{20}{24}, \frac{21}{24}$.
27. $\frac{128}{112}, \frac{80}{112}, \frac{56}{112}, \frac{112}{112}, \frac{45}{112}, \frac{232}{112}$.

Examples. 65.

1. $\frac{3}{4}$. 2. $\frac{9}{13}$. 3. $\frac{13}{16}$. 4. $\frac{16}{25}$. 5. $\frac{7}{8}$. 6. $\frac{29}{37}$.
7. $\frac{24}{25}$ greatest, $\frac{15}{16}$ least. 8. $\frac{10}{11}$ greatest, $\frac{7}{8}$ least.
9. $\frac{20}{21}$ greatest, $\frac{10}{31}$ least. 10. $\frac{15}{16}$ greatest, $\frac{2}{3}$ least.
11. $\frac{9}{10}$ greatest, $\frac{5}{13}$ least. 12. $\frac{9}{28}$ greatest, $\frac{7}{24}$ least.
13. $\frac{3}{4}, \frac{7}{12}, \frac{5}{9}$. 14. $\frac{18}{35}, \frac{7}{15}, \frac{4}{45}$. 15. $\frac{11}{13}, \frac{7}{9}, \frac{3}{5}$.
16. $\frac{15}{4}, 3\frac{2}{3}, \frac{27}{8}$. 17. $\frac{26}{303}, \frac{31}{363}, \frac{21}{25}$. 18. $\frac{118}{331}, \frac{143}{428}, \frac{37}{87}$.
19. $\frac{6}{7}, \frac{5}{8}, \frac{13}{28}, \frac{4}{9}$. 20. $\frac{113}{152}, \frac{51}{70}, \frac{2}{3}, \frac{7}{12}$. 21. $\frac{17}{12}, \frac{3}{4}, \frac{11}{15}, \frac{9}{20}$.

Examples. 66.

1. $2\frac{1}{4}$. 2. $1\frac{2}{7}$. 3. $\frac{8}{9}$. 4. $1\frac{6}{11}$. 5. $2\frac{7}{10}$. 6. $1\frac{49}{50}$.
7. 1. 8. $7\frac{3}{10}$. 9. $1\frac{2}{7}$. 10. $\frac{5}{6}$. 11. $1\frac{5}{12}$. 12. $1\frac{7}{36}$.
13. $1\frac{17}{240}$. 14. $1\frac{14}{35}$. 15. $1\frac{203}{240}$. 16. $1\frac{11}{12}$. 17. $\frac{47}{48}$.
18. $1\frac{31}{540}$. 19. $\frac{47}{180}$. 20. $4\frac{37}{105}$. 21. $2\frac{11}{60}$. 22. $\frac{103}{210}$.
23. $2\frac{41}{200}$. 24. $4\frac{8}{15}$. 25. $2\frac{173}{308}$. 26. $1\frac{301}{468}$.
27. $3\frac{43}{90}$. 28. 2. 29. $3\frac{1121}{1152}$. 30. $2\frac{541}{1080}$.

Examples. 67.

1. $7\frac{3}{4}$. 2. $14\frac{1}{8}$. 3. $12\frac{7}{20}$. 4. $15\frac{23}{36}$. 5. $23\frac{3}{5}$.
6. $29\frac{19}{56}$. 7. $5\frac{5}{8}$. 8. $41\frac{3}{35}$. 9. $10\frac{193}{462}$. 10. $11\frac{7}{31}$.
11. $14\frac{35}{64}$. 12. $11\frac{1}{2}$. 13. $160\frac{5}{7}$. 14. $34\frac{67}{78}$. 15. $13\frac{3}{8}$.
16. $31\frac{5}{16}$. 17. $976\frac{4}{21}$. 18. $154\frac{1}{8}$. 19. $17\frac{109}{147}$. 20. $6\frac{3}{16}$.
21. R29. 9*a*. $5\frac{29}{30}$*p*. 22. £7. 17*s*. $0\frac{9}{16}$*d*.
23. 15 yd. 2 ft. $6\frac{15}{16}$ in. 24. 12 lb. 1 oz. $2\frac{9}{16}$ dr.
25. 21 oz. 0 dwt. $19\frac{4}{5}$ gr. 26. 20 hr. 24 min. $33\frac{9}{48}$ sec.

Examples. 68.

1. $\frac{1}{4}$. 2. $6\frac{1}{4}$. 3. $\frac{1}{6}$. 4. $\frac{1}{12}$. 5. $\frac{11}{16}$. 6. $\frac{7}{72}$.
7. $\frac{16}{75}$. 8. $\frac{4}{15}$. 9. $\frac{23}{192}$. 10. $\frac{3}{14}$. 11. $\frac{51}{100}$. 12. $\frac{101}{120}$.
13. $\frac{121}{126}$. 14. $5\frac{8}{11}$. 15. $\frac{4}{15}$. 16. $\frac{5}{16}$. 17. $\frac{1}{3}$. 18. $\frac{5}{9}$.
19. $\frac{7}{16}$. 20. $\frac{103}{216}$. 21. $\frac{7}{12}$. 22. $\frac{6}{13}$. 23. $\frac{7}{12}$. 24. $\frac{11}{16}$.

Examples. 69.

1. $3\frac{1}{6}$. 2. $2\frac{7}{20}$. 3. $3\frac{1}{3}$. 4. $5\frac{5}{8}$. 5. $5\frac{4}{15}$.
6. $5\frac{2}{17}$. 7. $6\frac{31}{84}$. 8. $8\frac{5}{13}$. 9. $2\frac{5}{6}$. 10. $3\frac{23}{30}$.
11. $\frac{43}{48}$ 12. $5\frac{19}{21}$. 13. $2\frac{41}{64}$. 14. $8\frac{10}{49}$. 15. $9\frac{55}{63}$.
16. $9\frac{61}{81}$. 17. $10\frac{13}{63}$. 18. $6\frac{19}{120}$. 19. $6\frac{7}{24}$. 20. $9\frac{19}{24}$.
21. $2\frac{1}{2}$. 22. $6\frac{5}{8}$. 23. $8\frac{1}{12}$. 24. $9\frac{7}{17}$. 25. $8\frac{1}{3}$.
26. $12\frac{8}{11}$. 27. $13\frac{17}{18}$. 28. $10\frac{11}{21}$. 29. $1\frac{7}{12}$. 30. $6\frac{7}{48}$.
31. $6\frac{27}{56}$. 32. $7\frac{1}{12}$. 33. $3\frac{13}{18}$. 34. $2\frac{8}{15}$. 35. $9\frac{1}{4}$.
36. $\frac{15}{32}$. 37. $12\frac{20}{21}$. 38. $14\frac{3}{56}$. 39. $\frac{2}{7}$. 40. $\frac{1}{3}$.
41. R10 . 12 . $1\frac{1}{4}$. 42. R2 . 12 . $9\frac{1}{4}$. 43. R4 . 4 . $3\frac{7}{8}$.
44. £10 . 9 . $5\frac{7}{15}$. 45. £5 . 12 . $10\frac{3}{10}$. 46. 6 yd. $5\frac{3}{8}$ in.

Examples. 70.

1. $4\frac{2}{3}$. 2. 7. 3. $10\frac{1}{12}$. 4. $3\frac{6}{7}$. 5. $5\frac{1}{3}$.
6. $19\frac{1}{2}$ 7. $10\frac{1}{5}$. 8. 300. 9. $2\frac{4}{5}$. 10. $10\frac{1}{2}$.
11. $22\frac{1}{2}$. 12. $23\frac{3}{4}$ 13. $18\frac{33}{50}$. 14. $60\frac{3}{7}$. 15. 195.
16. $6\frac{4}{11}$. 17. $13\frac{1}{3}$. 18. $47\frac{2}{3}$. 19. $66\frac{6}{7}$. 20. $100\frac{8}{13}$.
21. $3\frac{9}{35}$. 22. $62\frac{1}{3}$. 23. $328\frac{5}{8}$. 24. $198\frac{3}{7}$. 25. 213.
26. $1224\frac{1}{3}$. 27. $487\frac{2}{7}$. 28. $177\frac{1}{3}$. 29. $26\frac{71}{100}$. 30. $38\frac{1}{6}$.
31. $18\frac{981}{1000}$. 32. $44\frac{119}{138}$. 33. $899\frac{91}{100}$.
34. $386\frac{1}{10}$. 35. $22999\frac{977}{1000}$. 36. $3190\frac{2}{3}$.
37. $209\frac{37}{100}$. 38. $6399\frac{71}{73}$. 39. £1 . 18 . $1\frac{1}{12}$.
40. £4 . 9 . $7\frac{3}{13}$. 41. R50 . 7 . $2\frac{1}{4}$. 42. R49 . 4 . $5\frac{1}{4}$.
43. £2 . 4 . 5. 44. £36 . 7 . $2\frac{1}{4}$.

Examples. 71.

1. $\frac{1}{8}$. 2. $\frac{2}{15}$. 3. $\frac{3}{28}$. 4. $\frac{1}{9}$. 5. $\frac{3}{64}$.
6. $\frac{3}{416}$. 7. $\frac{5}{144}$. 8. $\frac{9}{710}$. 9. $\frac{7}{37}$. 10. $\frac{88}{3125}$.
11. $\frac{11}{1320}$. 12. $\frac{7}{726}$. 13. $\frac{2}{323}$. 14. $\frac{2}{356}$. 15. $\frac{25}{2304}$.
16. $\frac{5}{1026}$. 17. $1\frac{5}{6}$. 18. $\frac{5}{12}$. 19. $\frac{1}{25}$. 20. $\frac{29}{66}$.
21. $1\frac{1}{9}$. 22. $\frac{2}{27}$. 23. $\frac{81}{168}$. 24. $\frac{2}{33}$. 25. $42\frac{2}{3}$.
26. $12\frac{11}{36}$. 27. $178\frac{1}{3}$. 28. $6\frac{17}{63}$. 29. $15\frac{379}{420}$. 30. $10\frac{883}{1056}$.
31. $6\frac{7}{15}$. 32. $38\frac{11}{200}$. 33. $21\frac{13}{21}$. 34. $1\frac{23}{30}$.
35. R1 . 5 . $6\frac{6}{13}$. 36. R2 . 8 . $7\frac{1}{13}$. 37. £1 . 17 . $6\frac{31}{88}$.
38. £7 . 13 . $10\frac{25}{156}$. 39. 80. 40. $192\frac{2}{7}$. 41. $43\frac{11}{35}$.

42. $112\frac{2}{11}$. **43.** $4\frac{11}{13}$. **44.** $26\frac{1}{7}$. **45.** $217\frac{33}{37}$. **46.** $146\frac{223}{328}$.
47. R2 . 9 . $0\frac{3}{8}$. **48.** R1 . 4 . $0\frac{6}{11}$. **49.** R32 . 5 . $6\frac{3}{14}$.
50. R6 . 4 . $2\frac{1}{18}$. **51.** £3 . 11 . $6\frac{1}{5}$. **52.** £3 . 19 . $11\frac{4}{15}$.

Examples 72

1. $\frac{5}{9}$. **2.** $\frac{21}{32}$. **3.** $\frac{2}{3}$. **4.** $\frac{8}{15}$. **5.** $4\frac{1}{2}$. **6.** $\frac{27}{200}$.
7. $\frac{2}{5}$. **8.** $\frac{8}{45}$. **9.** $\frac{3}{8}$. **10.** $3\frac{1}{3}$. **11.** $1\frac{2}{3}$. **12.** $2\frac{4}{7}$.
13. $32\frac{1}{22}$. **14.** $25\frac{5}{6}$. **15.** 3. **16.** $14\frac{2}{3}$. **17.** 10
18. 8. **19.** $28\frac{7}{18}$. **20.** $16\frac{5}{16}$ **21.** $9\frac{1}{2}$ **22.** 8.
23. $3\frac{3}{4}$. **24.** 35. **25.** 8 **26.** $15\frac{39}{84}$. **27.** $12\frac{3}{4}$.
28. $40\frac{1}{2}$ **29.** $286\frac{2}{27}$. **30** $\frac{3}{4}$ **31.** $2\frac{7}{20}$. **32.** $31\frac{1}{2}$.
33. $\frac{15}{27}$. **34.** $\frac{5}{24}$. **35.** $\frac{1}{12}$. **36.** 28. **37.** 294.

Examples 73.

1. 1386 in. **2.** 2574 in. **3.** 5742 in. **4.** 7722 in.
5. 9702 in. **6.** 39582 in. **7.** 673308 in. **8.** 274428 sq. in.
9. 509652 sq in. **10.** 1136916 sq in. **11.** 1528956 sq. in.
12. 1920996 sq. in. **13.** 59864508 sq. in. **14.** 4033699560 sq. in.

Examples. 74.

1. $1\frac{7}{8}$ **2.** $\frac{27}{56}$. **3.** 1. **4.** $1\frac{1}{27}$. **5.** $1\frac{5}{9}$.
6. 14 **7.** 3. **8.** $2\frac{3}{4}$ **9.** $18\frac{3}{5}$. **10.** $1\frac{1}{2}$.
11. $\frac{4}{5}$. **12.** $\frac{10}{11}$. **13.** $11\frac{2}{3}$. **14.** $6\frac{4}{7}$. **15.** $17\frac{1}{16}$
16. $9\frac{7}{32}$. **17.** $2\frac{119}{156}$. **18.** $1\frac{1}{2}$. **19.** $1\frac{1}{3}$. **20.** $2\frac{2}{5}$.
21. $\frac{8}{21}$. **22.** $1\frac{1}{2}$. **23.** $6\frac{7}{78}$. **24.** $3\frac{57}{176}$. **25.** 16.
26. $\frac{25}{48}$. **27.** $1\frac{1}{27}$. **28.** $\frac{6}{13}$. **29.** $93\frac{1}{3}$. **30.** The former.

Examples. 75.

1. $\frac{1}{14}$; 1. **2.** $\frac{3}{16}$; $2\frac{1}{4}$. **3.** $\frac{8}{147}$; $2\frac{2}{7}$. **4.** $\frac{2}{21}$; 8.
5. $\frac{1}{80}$; [illegible]0. **6.** $\frac{1}{12}$; $10\frac{1}{2}$. **7.** $\frac{1}{85}$; $409\frac{1}{2}$. **8.** $\frac{7}{40}$; [illegible]
9. $\frac{2}{3}$; $157\frac{1}{2}$. **10.** $1\frac{1}{2}$; 63. **11.** $1\frac{1}{3}$; 8. **12.** $\frac{28}{390}$; $70\frac{10}{13}$.
13. 3 in. **14.** $2\frac{2}{3}$. **15.** 1 min. 45 sec.

Miscellaneous Examples. 76.

1. $6\frac{1}{3}$. **2.** $1\frac{1}{6}$. **3.** $5\frac{1}{8}$. **4.** $\frac{1}{17}$. **5.** $\frac{1}{10}$. **6.** 5.
7. $16\frac{1}{12}$. **8.** $\frac{1}{2}$. **9.** £4 . 19 . $5\frac{1}{2}$. **10.** R840 . 6 . $10\frac{1}{2}$.
11. 950 lb. **12.** R1530. **13.** £50. **14.** $4\frac{1}{2} \times 3\frac{1}{2}$. **15.** $\frac{8}{9}$.

16. $\frac{1}{5}$. 17. $\frac{1}{60}$. 19. $\frac{2}{5}$. 20. $\frac{9}{40}$. 21. $\frac{1}{4}$. 22. $\frac{33}{100}$.
23. $\frac{21}{50}$. 24. $\frac{19}{180}$. 25. $\frac{3}{25}$. 26. $\frac{4}{5}$. 27. R60.
28. £720. 29. 15*s*. 30. 22 miles. 31. 400 inches.
32. 8, 6, 3, 2 ; 24 kings in all. 33. 34. 34. $1\frac{41}{51}$. 35. $\frac{14}{37}$.
36. 5 times. 37. $\frac{9}{13}$. 38. 27 hours. 39. $3\frac{1}{3}$. 40. 310.
41. 13 ; 17. 42. 36.

Examples. 77.

1. $\frac{2}{9}$. 2. $1\frac{9}{17}$. 3. $3\frac{3}{5}$. 4. 12. 5. $\frac{1}{16}$. 6. $2\frac{2}{25}$.
7. $\frac{303}{584}$. 8. $4\frac{1}{10}$. 9. $\frac{7}{15}$. 10. $\frac{3}{5}$. 11. 3. 12. 3.
13. $5\frac{1}{10}$. 14. $96\frac{4}{21}$. 15. 17. 16. $\frac{248}{327}$. 17. $4\frac{1}{2}$. 18. $\frac{3}{4}$.
19. $11\frac{5}{14}$. 20. $\frac{1}{11}$. 21. 18. 22. $8\frac{431}{800}$. 23. $\frac{5}{8}$. 24. $1\frac{17}{88}$.

Examples. 78.

1. $\frac{3}{5}$. 2. $1\frac{2}{3}$. 3. $\frac{8}{11}$. 4. $2\frac{204}{317}$. 5. $25\frac{1}{3}$. 6. $15\frac{2}{3}$.
7. $1\frac{68}{187}$. 8. $6\frac{816}{1261}$. 9. $4\frac{4}{75}$. 10. $\frac{4}{5}$. 11. $\frac{29}{70}$. 12. $\frac{9}{17}$.

Examples. 79.

1. $\frac{85}{512}$. 2. $\frac{4}{5}$. 3. $\frac{81}{125}$. 4. 6. 5. 1. 6. $1\frac{13}{32}$.
7. $1\frac{1}{4}$. 8. $\frac{1}{3}$. 9. $1\frac{1}{4}$. 10. $\frac{1}{14}$. 11. $\frac{1}{3}$. 12. $\frac{3}{17}$.
13. $3\frac{3}{10}$. 14. $\frac{1}{2}$. 15. 2. 16. $\frac{81}{128}$. 17. $22\frac{2}{5}$. 18. $\frac{1}{2}$.
19. 2. 20. $\frac{81}{128}$. 21. $22\frac{2}{3}$. 22. $\frac{24}{91}$. 23. $2\frac{11}{14}$. 24. $\frac{43}{80}$.

Examples. 80.

1. 3. 2. $3\frac{1}{2}$. 3. $\frac{97}{104}$. 4. $3\frac{5}{6}$. 5. $9\frac{17}{32}$. 6. $1\frac{4}{5}$.
7. 12. 8. $7\frac{5}{24}$. 9. $7\frac{7}{30}$. 10. $\frac{16}{35}$. 11. $4\frac{149}{240}$. 12. $1\frac{19}{252}$.
13. $4\frac{11}{36}$. 14. 1. 15. $\frac{41}{60}$. 16. $12\frac{4}{5}$. 17. $4\frac{287}{504}$. 18. $\frac{11}{14}$.

Examples. 81.

1. 1. 2. $1\frac{1}{4}$. 3. $7\frac{6}{13}$. 4. $6\frac{1}{21}$. 5. $\frac{28}{153}$.
6. $5\frac{11}{168}$. 7. $\frac{84}{9131}$. 8. $3\frac{91}{122}$. 9. $1\frac{121}{252}$. 10. $9\frac{13}{18}$.
11. $7\frac{3}{5}$. 12. $4\frac{1}{4}$. 13. $4\frac{3}{4}$. 14. $5\frac{3}{4}$. 15. $8\frac{11}{14}$.
16. $12\frac{5}{18}$. 17. [illegible] 18. 10. 19. $1\frac{4}{17}$. 20. $\frac{11}{16}$.
21. $\frac{1}{4}$. 22. $\frac{5}{8}$.

Examples. 82.

1. $\frac{9}{25}$. 2. 2. 3. 2. 4. $1\frac{8741}{10724}$. 5. $3\frac{1}{3}$.
6. $2\frac{74}{135}$. 7. 1. 8. $14\frac{1}{13}$. 9. $\frac{5}{31}$. 10. $1\frac{7}{8}$.

11.	$\frac{486}{2303}$.	12.	$\frac{30}{37}$.	13.	3.	14.	$5\frac{19}{250}$.	15.	$573\frac{3}{11}$.
16.	49	17.	$\frac{75}{77}$.	18.	$\frac{1}{12}$.	19.	$5\frac{1}{2}$.	20.	$5\frac{569}{40080}$.
21.	$1\frac{1}{24}$.	22.	$\frac{5}{7}$.	23.	1.	24.	4.	25.	$\frac{7}{8}$.
26.	1.	27.	$\frac{3}{35}$.	28	$\frac{515}{2268}$.	29.	$8\frac{73}{77}$.	30.	$10\frac{49}{188}$.
31.	$\frac{85}{176}$.	32.	$22\frac{3}{4}$.	33.	$\frac{123}{233}$.	34.	$3\frac{7}{10}$.	35.	$3\frac{29}{84}$.

Examples. 83.

1.	R3 . 10 . 4.	2.	R1 . 10 . 8.	3.	R1. 14*a*.
4.	R8 . 8 . 8.	5.	R1 . 3 . 6.	6.	7*a*. 6*p*.
7.	£33 . 16 . 4.	8.	£58 10*s*.	9.	£29. 14*s*.
10.	R70 . 9 . 4.	11.	R1 . 12 . 8.	12.	R1 . 2 . 8.
13.	R11 . 5 . $9\frac{7}{31}$.	14.	£38. 8*s*.	15.	6*s*. 3*d*.
16.	R52 . 6 . $10\frac{1}{2}$.	17.	R19 . 9 . $9\frac{1}{2}$.	18.	19*s*. $6\frac{9}{16}$*d*.
19.	£15 . 10 . $2\frac{1}{3}$.	20.	R284 . 2 . $6\frac{1}{22}$.	21.	£22 . 14 . $3\frac{34}{41}$.
22.	4 cwt. 2 qr. 24 lb. 12 oz.			23.	343 yd. 1 ft. $10\frac{2}{3}$ in.
24.	25 min. $25\frac{5}{13}$ sec.	25.	2 pk. $1\frac{11}{21}$ gall.	26.	R146 . 11 . 11.
27.	R1. 0 . $5\frac{1}{7}$.	28.	R122 . 3 . 8.	29.	£7 . 19 . $10\frac{1}{2}$.
30.	£22 . 1 . $9\frac{1}{23}$.	31.	R31 . 8 . $6\frac{3}{22}$.	32.	R5 . 10 . 7.
33.	10*s*. $11\frac{3}{12}$*d*.	34.	12*a*. $9\frac{1}{3}\frac{3}{9}$*p*.	35.	£2 . 8 . $7\frac{1}{2}$.
36.	16*s*. $10\frac{1}{2}$*d*.	37.	R3 . 5 . $1\frac{1}{7}$.	38.	R14 . 6 . $0\frac{104}{105}$.
39.	£3 . 18 . $5\frac{8107}{8288}$.	40.	$\frac{11}{12}$ of R6. 11*a*, $\frac{3}{4}$ of R7, R$\frac{2}{3}$.		
41.	£14 . 15 . 2.	42.	R8 . 9 . $4\frac{4}{5}$.	43.	R6 . 5 . $9\frac{3}{5}$.
44.	R217 . 15 . 6.	45.	18*s*. $9\frac{1}{3}\frac{3}{8}$*d*.		

Examples. 84.

1.	$3\frac{1}{4}$.	2.	$9\frac{3}{4}$.	3.	$5\frac{5}{16}$.	4.	$7\frac{1}{2}$.	5.	$7\frac{21}{40}$.	6.	$7\frac{3}{8}$.
7.	$7\frac{1}{3}$.	8.	$3\frac{1}{3}$.	9.	$\frac{103}{704}$.	10.	$\frac{299}{500}$.	11.	$\frac{412}{495}$.	12.	$\frac{113}{1792}$.
13.	$\frac{3}{82}$.	14.	$\frac{2971}{7920}$.	15.	$\frac{103}{1600}$.	16.	7.	17.	$\frac{181}{256}$.	18.	$\frac{451}{3960}$.
19.	[illegible]	20.	$2\frac{9417}{47718}$.	21.	$\frac{4169}{14878}$.	22.	$\frac{11}{20}$.	23.	$\frac{1}{3}$.		
24.	[illegible]	25.	$42\frac{9}{31}$.	26.	$52\frac{19}{21}$.	27.	$1\frac{471}{1792}$.	28.	$1\frac{319}{1028}$.		
29.	[illegible]	30.	[illegible]	31.	$\frac{77}{876}$.	32.	[illegible]	33.	$\frac{1}{8}$.		
34.	[illegible]	35.	[illegible]	36.	[illegible]	37.	276.	38.	$\frac{32}{2373}$.		
39.	[illegible]	40.	[illegible]	41.	$\frac{347}{361}$.	42.	$\frac{1}{10}$.	43.	9.		
44.	[illegible]	45.	[illegible]	46.	$\frac{8}{11}$.	47.	R8.	48.	$\frac{1}{37}$.		
49.	[illegible]	50.	[illegible]	51.	[illegible]	52.	$4\frac{1}{2}$.	53.	$\frac{5}{8}$.		

Miscellaneous Examples. 85.

1. $\frac{13}{48}$. 2. R72. 3. R8. 5*a*. 4*p*. ; R12. 8*a*. ; R12. 8*a*.
4. £7 . 2 . $1\frac{1}{2}$. 5. R3. 13*a*. $8\frac{2}{3}$*p*. 6. 19*s*. $11\frac{2}{5}$*d*.
7. £1 . 13 . $7\frac{3}{4}$. 8. $6\frac{6}{13}$ ft. 9. R122. 13. 9.
10. £2. 9*s*. 11. R1. 6*a*. 12. $\frac{2}{5}$. 13. $\frac{1}{8}$. 14. $\frac{31}{105}$.
15. $1\frac{1}{252}$. 16. $\frac{2}{57}$. 17. $\frac{1}{3}$*p*. 18. R785862
19. R3 . 4. 6. 20. $\frac{4}{25}$. 21. 72 oz. 22. 12 lb. avoir. 23. $\frac{1}{40}$.

Examples. 86.

1. ·3. 2. 2·01. 3. ·07. 4. ·104. 5. ·0008. 6. ·000009.
7. 12·04006. 8. ·013005. 9. ·00010001. 10. 100·502.
11. 70, ·7 ; 7000, ·007. 12. 290, 2·9 ; 29000, ·029.
13. 2, ·02 ; 200, ·0002. 14. ·2, ·002 ; 20, ·00002.
15. 34, ·34 ; 3400, ·0034. 16. 70·3, ·703 ; 7030, ·00703.
17. 10·03, ·1003 ; 1003, ·001003. 18. ·07, ·0007 ; 7, ·000007.
19. 392, 3·92 ; 39200, ·0392. 20. 234·5, 2·345 ; 23450, ·02345.
21. 30000, 300 ; 3000000, 3. 22. 1232, 12·32 ; 123200, ·1232.
23. ·1. 24. ·01. 25. 35 ; 70·5 ; 40. 26. ·25 ; ·06 ; ·3.

Examples. 87.

1. $\frac{3}{8}$. 2. $\frac{33}{100}$. 3. $\frac{1}{25}$. 4. $\frac{3}{4}$. 5. $\frac{31}{500}$.
6. $\frac{1}{80}$. 7. $\frac{1}{400}$. 8. $\frac{7}{40}$. 9. $\frac{72}{25}$. 10. $\frac{29}{40}$.
11. $\frac{12508}{3125}$. 12. $\frac{289}{40}$. 13. $\frac{5}{8}$. 14. $\frac{1}{16}$. 15. $\frac{111}{160}$.
16. $\frac{11}{16000}$. 17. $\frac{16001}{2000}$. 18. $\frac{103}{10}$. 19. $\frac{26031}{3200}$. 20. $\frac{3750001}{25000}$.
21. $2\frac{1}{2}$. 22. $7\frac{1}{4}$. 23. $8\frac{1}{3}$. 24. $1\frac{3}{4}$. 25. $2\frac{1}{40}$.
26. $3\frac{1}{20}$. 27. $9\frac{1}{80}$. 28. $6\frac{3}{400}$. 29. $3\frac{1}{2000}$. 30. $7\frac{27}{400}$.
31. $12\frac{9}{40}$. 32. $11\frac{1}{10}$. 33. $2\frac{1}{10000}$. 34. $1\frac{771}{3200}$. 35. $1\frac{889}{400000}$.
36. $12\frac{133}{2048}$. 37. ·7. 38. ·9. 39. 12. 40. 2·4.
41. ·003. 42. ·0725. 43. ·0329. 44. ·09. 45. 1·2345.
46. ·003. 47. 200·03. 48. ·01. 49. ·0125. 50. ·00079.

Examples. 88.

1. 20·163. 2. 37·479. 3. 43·31. 4. 80·33. 5. 10·36411.
6. 1. 7. 10. 8. 909·9099. 9. 14·53302. 10. 8.
11. 1000. 12. 417·81157. 13. 669·2981. 14. 657·2236.
15. 732·731. 16. R347·23478. 17. £747·0199.
18. 41·48[illegible] min. 19. 332·475 ft. 20. 41·307 in.

Examples. 89.

1. 7·084. **2.** 1·9711. **3.** 1·09922. **4.** 199·70334.
5. 62·65. **6.** 204·103. **7.** ·000275. **8.** ·0118766.
9. 7·5554623. **10.** 342·817. **11.** ·7. **12.** 2·063.
13. Rs7·0001. **14.** £·99949. **15.** 9·88309.
16. 696·162. **17.** 83·9583. **18.** 1999·25218.
19. 128·471. **20.** By 3·14159. **21.** By 2·7183.

Examples. 90.

1. 74·52. **2.** 36·2. **3.** ·13446. **4.** 6006.
5. ·001024. **6.** ·000324. **7.** 28·00028. **8.** 2456·8884.
9. 40·804. **10.** 30·228. **11.** 1·62023. **12.** ·0003125.
13. 4264014. **14.** 8. **15.** ·58. **16.** 8. **17.** 216·32.
18. 589·12. **19.** ·00008. **20.** ·0000423. **21.** ·0000373 8028.
22. ·819. **23.** ·0001. **24.** ·82008. **25.** 3·5.
26. 3091·7497. **27.** 1209·11. **28.** ·090. **29.** ·1344620025.
30. 48·6328503. **31.** 15·625. **32.** ·015625. **33.** ·00008.
34. 2·16. **35.** 1·331. **36.** 1. **37.** ·000000125.
38. 2401. **39.** ·00081. **40.** 27·5. **41.** 38·9375.
42. 2·607255. **43.** 7·5667. **44.** 90·0025. **45.** 421·36875.

Examples. 91.

1. 1·27. **2.** 1·372. **3.** 1·2. **4.** ·00043.
5. 1·99. **6.** ·0000479. **7.** ·000026375. **8.** 10·3.
9. ·000002. **10.** 17·125. **11.** ·0000000212. **12.** ·0528.
13. 1·84782... **14.** ·00009... **15.** 2·49367... **16.** ·00040...
17. ·00002... **18.** 3·71428... **19.** 1·30586... **20.** ·01900...
21. ·00003... **22.** 2·0625. **23.** ·46625. **24.** ·004857...
25. ·236. **26.** 12·181818... **27.** 2·29375. **28.** ·000540...
29. ·659. **30.** ·001666... **31.** 31·25. **32.** 352·25.
33. ·24. **34.** 2532. **35.** 1200. **36.** 640.
37. ·002. **38.** ·374. **39.** 20. **40.** 2040000.
41. 22500. **42.** 58070. **43.** 3596. **44.** 12132.
45. 17500. **46.** 1·4. **47.** 750000. **48.** ·007853.
49. [illegible]·18518... **50.** 5·20833... **51.** 33·33333... **52.** ·08366...
53. ·02320... **54.** ·00650... **55.** 33057851·23966...

56. 83·33325. **57.** 9·58904... **58.** ·01216... **59.** 350.
60. 752. **61.** 2·533333... **62.** 6·3125. **63.** ·000092...
64. 32714·285714... **65.** 5628·571428... **66.** 1191·75.
67. 1145·833333... **68.** ·018181... **69.** ·021428...
70. 377·777777... **71.** ·9. **72.** 8. **73.** ·27.
74. ·5. **75.** ·25. **76.** ·75. **77.** ·125. **78.** ·375.
79. 1·4375. **80.** 3·09375. **81.** 9·875. **82.** 3·28.
83. 2·68. **84.** ·33333... **85.** ·16666... **86.** ·28571...
87. ·27272... **88.** ·69230... **89.** 1·44444... **90.** 7·18181...
91. 8·33333... **92.** 10·34482... **93.** 58·41666...
94. ·8, ·75, ·6666... **95.** ·5, ·4166..., ·2727...
96. ·55, ·5333..., ·525. **97.** ·375, ·3125, ·2187...
98. ·44, ·4333..., ·35. **99.** ·7777..., ·7142..., ·6.
100. ·0216. **101.** ·1125. **102.** 3·135. **103.** ·2.

Examples. 92.

1. ·25 ; 108·75. **2.** ·03 ; 72·12. **3.** ·004 ; ·4. **4.** ·24 ; 6.
5. ·005 ; 1·6. **6.** ·12 ; 7·2. **7.** ·0001 ; ·08. **8.** ·06 ; 11754·6.
9. ·03 ; 1·8. **10.** ·06 ; 180. **11.** ·05 ; 140. **12.** ·025 ; 1·5.

Examples. 93.

1. Non-terminating. **2.** Terminating. **3.** N.-T. **4.** T.
5. N.-T. **6.** N.-T. **7.** N.-T. **8.** N.-T. **9.** N.-T.
10. N.-T. **11.** T. **12.** T. **13.** T. **14.** T.
15. N.-T. **16.** 3, 6, 7, 9, 11, 12, 13, 14, 15, 17, 18, 19.

Examples. 94.

1. $\cdot\dot{3}$. **2.** $\cdot\dot{2}$. **3.** $\cdot\dot{7}1428\dot{5}$. **4.** $1\cdot1\dot{6}$. **5.** $1\cdot\dot{1}\dot{8}$.
6. $1\cdot\dot{5}3846\dot{1}$. **7.** $\cdot4\dot{6}$. **8.** $1\cdot\dot{0}0\dot{9}$. **9.** $\cdot2\dot{7}$. **10.** $3\cdot\dot{2}3076\dot{9}$.
11. $11\cdot\dot{9}0476\dot{1}$. **12.** $\cdot0\dot{4}\dot{5}$. **13.** $3\cdot\dot{7}8000\dot{3}$.
14. $\cdot208\dot{3}$. **15.** $3\cdot8\dot{8}4615\dot{3}$. **16.** $7\cdot\dot{4}8\dot{1}$. **17.** $5\cdot\dot{2}8571\dot{4}$.
18. $10\cdot\dot{0}7692\dot{3}$. **19.** $7\cdot1\dot{3}$. **20.** $9\cdot6\dot{4}2857\dot{1}$. **21.** $1\cdot0\dot{0}19\dot{8}$.
22. $13\cdot94\dot{2}3076\dot{9}$. **23.** $4\cdot803\dot{5}7142\dot{8}$. **24.** $3\cdot45\dot{5}609\dot{7}$. **25.** $5\cdot\dot{1}\dot{2}$.
26. $\cdot\dot{6}$. **27.** $6\cdot\dot{5}7142\dot{8}$. **28.** $1\cdot7\dot{7}\dot{2}$. **29.** $\cdot\dot{1}2698\dot{4}$.
30. $4\cdot8$. **31.** $\cdot1\dot{6}$. **32.** $\cdot01\dot{5}$. **33.** $\cdot0\dot{0}1\dot{5}$. **34.** $\cdot0\dot{0}01\dot{5}$.
35. $\cdot0\dot{0}001\dot{5}$. **36.** $8\cdot10\dot{6}$. **37.** $3\cdot13\dot{7}1428\dot{5}$.

38. ·0588235294117647. **39.** 2·105263157894736842.
40. ·0869565217391304347826. **41.** 10·90. **42.** ·099900.
43 2·307692. **44.** 2·857142. **45** 27·27. **46.** 2·27.
47. 7·8695652173913043478260. **48.** 16·714285. **49.** 6·076923.
50. 642·857142. **51.** ·83. **52.** ·00072.

Examples. 95.

1. ·234534. **2.** ·34767. **3.** 67676. **4.** ·23454.
5. ·001231. **6.** ·123452. **7.** ·1234123. **8.** ·12345623.
9. ·3444444, ·242424, ·2678678.
10. ·10202020202, ·12342342342344, ·37653765376 5.
11. ·233, ·787. **12.** ·345, ·767, ·722. **13.** ·3077, ·7676.
14. ·076767, ·777777, ·000123. **15.** ·238888, ·123412, ·023232.
16. ·3331, ·7676, ·7230. **17.** ·7777777, ·1424242, ·2472372 3.
18. 3·4444414, ·2686868, ·1231231. **19.** 3·4022, ·7822, ·3111.
20. ·4232323, ·7272727, ·1203203.

Examples. 96.

1. $\frac{2}{3}$. **2.** $\frac{2}{11}$. **3.** $\frac{1}{7}$. **4.** $\frac{10}{11}$. **5.** $\frac{5}{18}$. **6.** $\frac{49}{180}$. **7.** $\frac{25}{88}$.
8. $\frac{29}{900}$. **9.** $\frac{157}{19980}$. **10.** $\frac{163}{19800}$. **11.** $\frac{527}{495000}$. **12.** $\frac{9}{110}$.
13. $3\frac{13}{099}$. **14.** $3\frac{214}{455}$. **15.** $7\frac{11}{495}$. **16.** $31\frac{7}{900}$. **17.** $\frac{593}{999}$.
18. $\frac{1}{13}$. **19.** $2\frac{13}{21}$. **20.** $10\frac{271}{1850}$. **21.** $\frac{57}{30000}$. **22.** $\frac{1}{88}$.
23. $\frac{27}{3700}$. **24.** $\frac{103}{270}$. **25.** $\frac{1}{148}$. **26.** $\frac{4}{165}$. **27.** $\frac{42}{111}$.
28. $\frac{767}{3330}$. **29.** $\frac{1}{3096}$. **30.** $\frac{9901}{99000}$. **31.** $3\frac{7}{900}$. **32.** $\frac{22}{1333}$.
33. $\frac{11}{3}$. **34.** $\frac{79}{11}$. **35.** $\frac{121}{90}$. **36.** $\frac{85}{30}$. **37.** $\frac{193}{180}$.
38. $\frac{911}{300}$. **39.** $\frac{3301}{330}$. **40.** $\frac{20023}{4995}$. **41.** $\frac{11753}{1650}$. **42.** $\frac{1699}{222}$.
43. $\frac{44419}{2220}$. **44.** $\frac{139991}{9990}$. **45.** $\frac{441}{44}$. **46.** $\frac{725}{52}$.
47. $\frac{30467}{3333}$. **48.** $\frac{29991}{999}$. **53.** ·1. **54.** ·368. **55.** 1·7.
56. ·001. **57.** ·3. **58.** 4. **59.** 4. **60.** ·105.

Examples. 97.

1. 3·78. **2.** ·7932. **3.** 11·095. **4.** 6·48453. **5.** 4·8287.
6. 1·0343082901. **7.** 2·8579. **8.** 8·98. **9.** 10·345.
10. 8·002. **11.** ·10291837. **12.** 5·348655. **13.** 19·17230127.
14. ·0093666 3. **15.** 11·17997. **16.** 1·723082719. **17.** 9.
18. [illegible] **19.** 75·01354643572465. **20.** 4.

21. $11\cdot597\dot{7}94\dot{2}$ **22.** $2\cdot6542\dot{9}8744\dot{1}$. **23.** $92\cdot468\dot{7}5155653673\dot{4}$.
24. $3\cdot75\dot{9}\dot{3}$. **25.** $3\cdot0\dot{7}77704\dot{9}$ **26.** $\cdot39\dot{4}89560667778\dot{8}$.
27. $\cdot\dot{9}1100\dot{1}$. **28.** $3\cdot3876\dot{5}$. **29.** $2\cdot472\dot{8}7\dot{6}$. **30.** $6\cdot76\dot{5}2\dot{3}$.
31. $\cdot891\dot{6}$. **32.** $6\cdot345\dot{8}$. **33.** $2\cdot46\dot{4}4933412260\dot{1}$.
34. $\cdot4\dot{3}1\dot{2}$ **35.** $3\cdot89\dot{3}8629\dot{5}$. **36.** $\cdot7\dot{1}6160534972\dot{4}$.
37. $3\cdot\dot{6}4422553\dot{3}\dot{1}$. **38.** $\cdot123\dot{0}78\dot{6}$. **39.** $771\cdot0735\dot{1}2758\dot{2}$.
40. $\dot{2}96230196\dot{5}$.

Examples. 98.

1. $\cdot00\dot{2}$. **2.** $1\cdot\dot{1}8\dot{5}$. **3.** $1\cdot338842\ldots$ **4.** $\cdot\dot{1}\dot{6}$.
5. $\cdot\dot{1}08641975\dot{3}$. **6.** $51\cdot\dot{9}6\dot{2}$. **7.** $\cdot5$. **8.** $106\cdot5625$.
9. $2335\cdot882352\ldots$ **10.** $1\cdot518141\ldots$ **11.** $2\cdot794932\ldots$
12. $\cdot7\dot{8}5714\dot{2}$. **13.** $\cdot236232\ldots$ **14.** $\cdot08\dot{2}8185\dot{3}$. **15.** $69\cdot3\dot{9}5\dot{7}$.

Examples. 99.

1. $120\cdot\dot{4}2837\dot{1}$. **2** $13316\cdot875$. **3.** $\cdot0\dot{7}\dot{5}$. **4.** 5.
5. $\frac{5720}{11329}$ or $5048\ldots$ **6** 350. **7.** $\cdot12$. **8.** $\cdot0348\dot{5}$ **9.** 20.
10. $\cdot\dot{3}8095\dot{2}$. **11.** $\cdot125$. **12.** $11344\cdot\dot{6}$. **13.** 8.
14. $\frac{4675}{20993}$ or $22269\ldots$ **15.** $998\cdot001$. **16.** $32\cdot\dot{2}$.

Examples. 100.

1. $1372\cdot8p$. **2.** $4\cdot5p$. **3.** $32\frac{1}{2}d$. **4.** $36q$. **5.** $30p$.
6. $302\cdot4q$. **7.** $1580\cdot8p$. **8.** $95\cdot3d$. **9.** $1603\cdot84$ oz.
10. $789\cdot03$ in. **11.** R7. 5*a*. 2·4*p*. **12.** £3. 7*s*. **13.** R2. 0*a*. 3·84*p*.
14. R2. 6*a*. 7·5*p*. **15.** £2. 15*s*. 2·4*d*. **16.** 12*a*. 11·52*p*.
17. R34. 4*a*. 3·84*p*. **18.** 1 ft. 1·824 in. **19.** 4 cwt. 2 qr. 20·16 lb.
20. 12*a* 8·5*p*. **21.** R6. 12*a*. 9*p*. **22.** R12. 5*a*. 1·2*p*.
23. R4. 9*a*. 1·2*p*. **24.** R45. 1*a*. 6*p*. **25.** R2. 12*a*. 10·464*p*.
26. 16*s*. 6·912*d*. **27.** 1*s*. 9·09375*d*. **28.** 2·7*d*.
29. R2 8*a*. 6·7*p*. **30.** £4. 13*s*. 9*d*. **31.** 1*s*. 7·125*d*.
32. 10 md. 13 seers 4·84 ch. **33.** 1 ton 8 cwt. 1 qr. 8 lb.
34. 2 po. 2 yd. 1 ft. 3·9375 in. **35.** 22 hr. 19 min. 4·375 sec.
36 R7. 12*a*. **37.** 2*s*. 3·01$\frac{5}{}$*d*. **38.** R113. 7*a*. **39.** R7. 13*a*.
40. £168. 7*s*. 5·$\dot{0}\dot{9}$*d*. **41.** R68. 3*a*. 1·2*p*. **42.** R15. 2*a*. 4*p*.
43. R3. 14*a*. **44.** R17. 1*a*. 8*p*. **45.** R4. 15*a*. 3·$\dot{8}$9$\dot{1}$*p*.
46. £1. 3*s*. 0$\frac{3}{4}$*d*. **47.** 12*s*. 1$\frac{1}{4}$*d*. **48.** £34. 14*s*. 6·7916*d*.

49. $\frac{11}{12}$ of R3. 9*a*., ·025 of R100. 10*a*., ·3$\dot{2}$ of R5. 8*a*.
50. $3\frac{1}{8}$ of 1*d*., ·256 of 1*s*., ·0034$\dot{4}$ of £1. **51.** R4. 12*a*. 2·$\dot{6}$*p*.
52. 2·$\dot{5}9\dot{2}$*d*. **53.** $9\frac{569}{575}$*d*. **54.** 16*s*. **55.** R68. 2*a*. 5·825536*p*.
56. 1 ton 17 cwt. 2 qr. 4 lb. **57.** 6 md. **58.** $\frac{1}{8}$*d*.

Examples. 101.

1. R17·359375. **2.** £8·79791$\dot{6}$. **3.** 4·46$\dot{4}$28571$\dot{4}$ tons.
4. 1·420$\dot{4}\dot{5}$ mi. **5.** ·771597$\dot{2}$ da. **6.** £40·95. **7.** 7·75.
8. 3·640625. **9.** 5·3385416$\dot{6}$. **10.** 8·5. **11.** 1·18$\dot{3}$.
12. 7·31875. **13.** 1·375. **14.** 3·95. **15.** 5·$\dot{7}\dot{2}$.
16. 7·23958$\dot{3}$. **17.** 1·0042011... **18.** 7·03$\dot{8}$. **19.** ·659375.
20. ·751875. **21.** ·$\dot{8}\dot{2}9\dot{6}$. **22.** ·620543... **23.** ·481283...
24. ·578481... **25.** 1·06875. **26.** 1·04513$\dot{8}$. **27.** 1·045918...
28. ·4$\dot{7}$80219$\dot{9}$. **29.** 15·054375. **30** ·009$\dot{1}$4285$\dot{7}$. **31.** ·26041$\dot{6}$.
32. ·$\dot{3}\dot{6}$. **33.** ·208$\dot{3}$. **34.** ·755$\dot{9}$5238$\dot{0}$. **35.** ·0$\dot{1}$. **36.** ·171$\dot{2}9\dot{6}$.
37. ·3$\dot{5}$. **38.** ·0102339... **39.** ·$\dot{0}$3846$\dot{1}\dot{5}$. **40.** ·328.

Miscellaneous Examples. 102.

1.
2. ·007$\dot{6}$; $\frac{19}{2475}$. **3.** ·7$\dot{2}$; $\frac{3444}{5600}$. **4.** ·000282. **5.** ·362.
6. R225. 11*a*. 3*p*. **7.** 1 ton 19 cwt. 3 qr. 3 lb. **8.** ·50$\dot{6}$.
9. R9000. **10.** ·6962. **11.** 64·09, 49·3, 1·3. **12.** 1520640.
13. 8000 times. **14.** 29 times ; 1·576 gallons over.
15. 21 times ; rem. 2·02. **16.** ·5. **17.** 1508·04*d*. **18.** 7·059 tons.
19. 8·571875 lb. **20.** £33. 1*s*. $1\frac{1}{2}$*d*. **21.** 4·255. **22.** ·00584.. in.
23. 45 yd. 2·1812 ft. **24.** 1142 ; ·054 in **25.** ·8095.
26. 81·649296. **27.** 448·52990016. **28.** 8. **29.** 8000.
30. ·15. **31.** R2. 9*a*. 8*p*. **32.** R81000. **33.** 9·5087...
34. 4·5 lb. greater. **35.** 15·$\dot{1}$ years. **36.** 36 min. 24 sec.
37. 2*s*. 6*d*. **38.** R20, R30. **39.** *A*, £36 ; *B*, £12 ; *C*, £4. **40.** $\frac{1}{2}$.

Examples. 103.

1. 2·1053. **2.** ·05882. **3.** 1·0313. **4.** 75·014.
5. ·3949. **6.** 1·11. **7.** 2·00. **8.** 1·50.
9. 1·33. **10.** 1·250. **11.** 1·167. **12.** ·26667.
13. 1·41069. **14.** ·28768. **15.** ·20273.

Examples. 103 a.

1. 7·306. 2. 4·233. 3. ·0076. 4. 1180·5103.
5. 18979409. 6. 64·20153. 7. 7·704746. 8. ·392754.
9. 66·939. 10. ·143292. 11. 1·617. 12. ·344.
13. 1·229. 14. 12·310. 15. ·1178. 16. 193·7204.
17. 530·13237. 18. 8231·60553. 19. 1072·476227.
20. 10841017079601. 21. ·281. 22. 23·207065.

Examples. 104.

1. R1300. 2. £843. 15s. 3. R49. 5a. 4. £9. 2s.
5. R6. 13a. 9p. 6. £1675. 16s. 7. R327. 12a.
8. £542. 5s. 9. R2523. 9a. 10. £4. 11s. 8d.
11. R400. 12a. 6p. 12. £42. 15s. 13. R226. 9a.
14. £341. 9s. 6d. 15. R453. 14a. 6p. 16. £8. 11s. 5d.
17. R747. 5a. 3p. 18. £1730. 15s. 19. R2830. 12a. 6p.
20. £8002. 7s. 4d. 21. R4894. 2a. 8p. 22. £251. 15s. $6\frac{3}{4}$d.
23. R7033. 7a. 3p. 24. £45531. 11s. 3d. 25. R38397. 10a. 6p.
26. £280508. 13s. $7\frac{1}{2}$d. 27. R15060. 28. £11714. 18s. $11\frac{1}{2}$d.
29. R191898. 12a. 30. £2771. 19s. 3d. 31. R49514. 3a. $9\frac{3}{4}$p.
32. £39247. 4s. $2\frac{1}{4}$d. 33. R644434. 11a. $4\frac{1}{3}$p. 34. £78979. 3s. 4d.
35. R3003. 36. £243. 15s. $5\frac{1}{10}$d. 37. R20994. 8a. $10\frac{1}{2}$d.
38. £838. 3s. $3\frac{1}{16}$d. 39. R34075. 14a. $0\frac{1}{18}$p.
40. £33673. 9s. $10\frac{9}{32}$d. 41. R7661. 9a. $0\frac{5}{8}$p.
42. £5027. 11s. $0\frac{13}{16}$d. 43. R72. 6a. 8p. 44. £236. 4s. $9\frac{3}{4}$d.
45. R1073. 15a. $0\frac{3}{4}$p. 46. £31. 9s. $1\frac{31}{32}$d.

Examples. 105.

1. R25. 10a. $6\frac{1}{2}$p. 2. R44. 0a. 8p. 3. £93. 0s. $5\frac{3}{5}$d.
4. £68. 14s. 9d. 5. £1347. 3s. $3\frac{1}{16}$d. 6. £108. 15s. $3\frac{4}{7}$d.
7. £57. 8s. 8. R38. 2a. $10\frac{3}{4}$p. 9. R100. 7a. $10\frac{77}{128}$p.
10. R67. 7a. 2p. 11. R27. 0a. $2\frac{1}{4}$p. 12. 8s. $1\frac{1}{2}$d.
13. £2. 6s. $1\frac{1}{2}$d. 14. £150. 17s. $6\frac{175}{448}$d. 15. £59. 3s. $1\frac{1}{2}$d.
16. R1835. 11a. $9\frac{19}{56}$p. 17. R180. 2a. 3p. 18. £109. 17s. 3d.
19. R4067. 2a. $4\frac{7}{8}$p. 20. £4279. 6s. $7\frac{1}{2}$d.
21. 1 last 0 ld. 4 qr. 7 bus. $0\frac{9}{16}$ pk. 22. 19 cwt. 3 qr. $9\frac{8}{13}$ lb.

23. £11. 15s. $7\frac{1}{8}$d. **24.** 30 tons 6 cwt. 1 qr. 14 lbs.

25. 2529 md. 7 seers 8 ch. **26.** £26. 15s. $10\frac{1}{2}$d.

27. R265. 9a. $5\frac{1}{3}$p. **28.** £14. 15s. $5\frac{1}{4}$d. **29.** R45. 4a. 6p.

30. £239. 7s. $9\frac{3}{4}$d. **31.** R92. 1a. $5\frac{3}{5}$p. **32.** R959. 7a. 7p.

33. £9. 17s. $0\frac{1381}{5600}$d. **34.** R4664. 3a. $10\frac{1}{2}$p. **35.** R7999. 15a. $9\frac{1}{18}$p.

Examples. 106.

1. 21. **2.** 24. **3.** 27. **4.** 31. **5.** 32. **6.** 81.
7. 75. **8.** 96. **9.** 165. **10.** 234. **11.** 222. **12.** 135.
13. 345. **14.** 440. **15.** 804. **16.** 847. **17.** 2222. **18.** 1679.
19. 1001. **20.** 1234. **21.** 9070. **22.** 7906.
23. 9876. **24.** 4607. **25.** 56804. **26.** 80047
27. 15367. **28.** 600098. **29.** 543200. **30.** 123456789.
31. 41. **32.** 80. **33.** 76. **34.** 105. **35.** 252 **36.** 5.

Examples. 107.

1. 30. **2.** 40. **3.** 18. **4.** 24. **5.** 36
6. 64. **7.** 42. **8.** 84. **9.** 105. **10.** 231.
11. 315 **12.** 756. **13.** 504. **14.** 6006. **15.** 66990.
16. 2. **17.** 15. **18.** 2. **19.** 3600. **20.** 900.

Examples. 108.

1. 3·4. **2.** 2·17. **3.** 6·25. **4.** 9·08. **5.** ·08.
6. ·073. **7.** 32·9. **8.** 2·403. **9.** ·0231. **10.** ·0045.
11. 15·367. **12.** ·897. **13.** ·001849. **14.** 1·001.
15. 958·8669. **16.** 27·6025... **17.** 1·3038... **18.** 15·4147...
19. 2·2360... **20.** 29·6063... **21.** ·3162... **22.** ·7071...
23. 4·8062... **24.** ·9486... **25.** 4·4721... **26.** ·1264...
27. ·0252... **28.** 2·6457... **29.** 8·1240... **30.** 3·6055...

Examples 109.

1. $\frac{14}{75}$. **2.** $74\frac{1}{2}$. **3.** $5\frac{5}{7}$ **4.** $10\frac{1}{20}$. **5.** $1\frac{1}{5}$. **6.** $1\dot{6}$.
7. $5\cdot\dot{3}$. **8.** $1\cdot8\dot{3}$. **9.** $2\cdot8\dot{3}$. **10.** $\cdot2\dot{6}$. **11.** 1·322...
12. ·845... **13.** ·816... **14.** ·790... **15.** ·763... **16.** ·577...
17. ·645... **18.** 1·568... **19.** ·632... **20.** 20·493... **21.** $7\frac{3}{7}$.

Examples. 110.

1. 2·236067... **2.** 4·123105... **3.** 27·602536... **4.** ·019598...
5. ·774596... **6.** 1·732050... **7.** ·264575... **8.** ·921954...
9. 87·286883... **10.** ·612372... **11.** 15·414765... **12.** 1·303840...
13. ·845154... **14.** 4·882304... **15.** ·030708... **16.** 3·162277...

Examples. 111.

1. **2.** **3.** 36. **4.** 48. **5.** 49.
6. **7.** 13. **8.** 57. **9.** 89. **10.** 97.
11. 247. **12.** 473. **13.** 945. **14.** 956. **15.** 6031.
16. 551. **17.** 9009. **18.** 2222. **19.** 45333. **20.** 11111111.

Examples. 112.

1. 2·6. **2.** 5·1. **3.** ·79. **4.** 40·1. **5.** 2·65. **6.** ·197.
7. ·957. **8.** ·101. **9.** $\frac{4}{7}$. **10.** $\frac{9}{13}$. **11.** $3\frac{3}{8}$. **12** $19\frac{5}{8}$.
13. $\cdot\dot{3}$. **14.** $11\cdot\dot{6}$. **15.** $15\cdot\dot{6}$. **16.** $3\frac{3}{5}$. **17.** $2\frac{3}{4}$. **18.** $1\cdot\dot{3}$.
19. 1·523... **20.** 2·223... **21.** 2·884... **22.** 1·959... **23.** ·928...
24. ·646... **25.** ·464... **26.** ·585... **27.** ·167... **28.** 1·759...

Examples. 113.

1. 1·523913. **2** 2·884499... **3.** 1·959172...
4. ·125992... **5.** ·144224... **6.** 2·648751...

Examples. 114.

1. 4. **2.** 22. **3.** 36. **4.** 6·3. **5.** 9.
6. 2·6. **7.** 54. **8.** 4. **9.** 5. **10.** 2·434...

Examples. 115.

1. 180 sq. ft. **2.** 320 sq. ft. **3.** 117 sq. ft.
4. 64 sq. ft. 106 in. **5.** 78 sq. ft. $51\frac{3}{4}$ in. **6.** 70 sq. yd. 8 ft.
7. 11 ft. **8.** 2 ft. 4 in. **9.** 99 yd. **10.** 8 ft. 9 in.
11. 1067 sq. ft. 16 in. **12.** 14 sq. yd. 81 in. **13.** 392.
14. 18. **15.** R136. 8*a*. **16.** £9 15*s*. **17.** 120 sq. ft.
18. 556 sq. yd. **19.** 15888. **20.** R160. 15*a*.
21. $78\frac{3}{4}$ sq. yd. £1. [illegible]*s*. 3*d*. **22.** 4800 sq. ft. **23.** 15 ft.
24. $21\frac{15}{16}$ sq. ft. **25.** $1\frac{4}{5}$ in **26.** $2\frac{3}{7}$ in. **27.** R1112. 8*a*.
28. 26 yd. 2 ft. **29.** 1024 sq. ft. **30.** 300. **31.** R666. 12*a*.

Examples. 116.

1. 220 yd. 2. 22 ft. 5 in. 3. 280 yd. 4. 50 yd.
5. 5·656...yd. 6. 42·42...ft. 7. 18 ft. 8. 48 yd. 9. 34 yd.
10. 77 yd. 2 ft. 11 in.

Examples. 117.

1. 60 yd. 2. 37 yd. $1\frac{1}{3}$ in. 3. 60 yd. $1\frac{2}{7}$ in.
4. R44. 7*a*. $1\frac{1}{3}$*p*. 5. £23. 1*s*. 3*d*. 6. 648 sq. ft.
7. 495 sq. ft. 8. 88 sq. yd. 6 ft. 9. 288 yd.
10. 96 yd. 11. 211 yd. 12. 176 yd. 2 ft. $1\frac{1}{8}$ in.
13. R46. 4*a*. 14. £17. 15. £5. 0*s*. $4\frac{1}{8}$*d*.
16. $157\frac{1}{5}$ yd. 17. R1. 10*a*. $7\frac{1}{6}$*p*. 18. 4*s*. $8\frac{34}{175}$*d*. 19. $2\frac{1}{2}$ yd.
20. $16\frac{1}{8}$ in. 21. R3499. 3*a*. 6*p*. 22. R114. 12*a*. 23. $5\frac{3}{4}$ ft.
24. R83. 14*a*. $10\frac{2}{7}$*p*. 25. R19. 14*a*. 26. $5\frac{13}{18}$.
27. Width, $18\frac{1}{2}$ ft.; height, $14\frac{1}{2}$ ft. 28. R13. 6*a*.

Examples. 118.

1. 12 bi. 2. 52 bi. 10 cot.
3. 108 bi. 7 cot. 8 ch. 4. 207 bi. 7 cot. 3 ch. 4 ga.
5. 357 bi. 9 cot. 3 ch. 4 ga. 6. 2427 bi. 8 cot.
7. 4992 bi. 10 cot. 16 ga. 8. 12188 bi. 19 cot. 14 ch. 8 ga.
9. 27 bi. 12 cot. 8 ch. 10. 8 bi. 1 cot. 4 ch.
11. 6 bi. 9 cot. 2 ch. 8 ga. 12. 19 bi. 12 cot. 11 ch. 4 ga.

Examples. 119.

1. 400 cu. ft. 2. $183\frac{3}{4}$ cu. ft. 3. $157\frac{1}{2}$ cu. ft.
4. $8\frac{3}{4}$ cu. ft. 5. $4952\frac{83}{88}$ cu. ft. 6. $42\frac{7}{8}$ cu. ft.
7. $843\frac{3}{4}$ lb. 8. 10080. 9. 3750 times. 10. 48 min.
11. 24. 12. 1 ton 16 cwt. 13. 2800 times. 14. $\cdot0\dot{2}\dot{7}$.
15. $62\frac{1}{2}$. 16. $4\frac{1}{4}$. 17. 16 ft. 9 in. 18. 2 ft.
19. R1466. 10*a*. 8*p*. 20. $16407\frac{207}{224}$ tons. 21. R170.
22. $133\frac{1}{3}$. 23. 4 in. 24. 3 yd. 25. $256\frac{1}{2}$ lb. 26. 675 lb.
27. 60. 28. 15·404i ft. 29. R5520. 30. R276. 5*a*. 3*p*.; 31440.

Examples. 120.

1. 4 yd. $7\frac{5}{18}$ in. 2. 6 yd. 2 ft. $8\frac{5}{18}$ in.
3. 1 sq. yd. 4 ft. 111 in. 4. 2 sq. yd. 4 ft. $40\frac{5}{8}$ in.

5. 4 sq. yd. 4 ft. $12\frac{1}{4}$ in.
6. 2 sq. ft. $26\frac{1}{72}$ in.
7. 1 cu. yd. 3 ft. 480 in.
8. 2 cu. yd. 20 ft. 1048 in.
9. 10 cu. ft. $300\frac{1}{3}$ in.
10. 3 cu. ft. $471\frac{13}{48}$ in.
11. 8 ft. 7'.
12. 34 ft. 7'. 6".
13. 8 ft. 11'. 6". 8'''.
14. 10 ft. 9'. 10". 6'''.
15. 56 sq. ft. 5'. 11." 6'''.
16. 70 sq. ft. 5'. 0". 4'''. 6^{iv}.
17. 62 cu. ft. 1'. 0". 6'''. 8^{iv}.
18. 28 cu. ft. 1'. 8". 0'''. 5^{iv}. 4^{v}.

Examples. 121.

1. 7 sq. ft. 72 in.
2. 67 sq. ft. 12 in.
3. 132 sq. ft. 117 in.
4. 217 sq. ft. 14 in.
5. 316 sq. ft. 36 in.
6. 129 sq. ft. 54 in.
7. 98 sq. ft. $80\frac{11}{12}$ in.
8. 130 sq. ft. 140 in.
9. 228 sq. ft. $83\frac{27}{64}$ in.
10. 2459 sq. ft. $107\frac{49}{81}$ in.
11. 38 cu. ft. 1161 in.
12. 127 cu. ft. 304 in.
13. 874 cu. ft. $1510\frac{1}{3}$ in.
14. 471 cu. ft. $585\frac{23}{24}$ in.
15. 3309 cu. ft. $453\frac{11}{16}$ in.

Examples. 122.

1. 6*a*. 2. R2. 8*a*. 3. 4*a*. 4. 2 md. 20 seers. 5. 2 ft.
6. 7*s*. $5\frac{7}{13}$*d*. 7. 5*p*. 8. R35. 12*a*. 9. 5*s*. 10*d*. 10. $36\frac{2}{3}$.
11. $34\frac{11}{18}$ mi. 12. £2. 12*s*. 6*d*. 13. 5*a*. 14. R21.

Examples. 123.

1. 30 da. 2. 60. 3. 270 da. 4. 700 mi. 5. 91.
6. $4\frac{1}{2}$ da. 7. 7. 8. $4\frac{1}{2}$ da. 9. 11.
10. 4 md. 11. 270. 12. 270. 13. 2.

Examples. 124.

1. R2079. 2. R20. 3. R15. 12*a*. 4. R650.
5. £10. 10*s*. 6. R48. 7*a*. 7. 240. 8. 48.
9. £12. 13*s*. 10. 36 lb. 11. R8. 12*a*. 12. R9. 11*a*. $4\frac{1}{2}$*p*.
13. 20. 14. $8\frac{1}{2}$*d*. 15. £2. 6*s*. 8*d*. 16. 7*a*. 6*p*.
17. R3937. 8*a*. 18. £816. 16*s*. 19. R17640. 20. R240.
21. R472. 13*a*. $7\frac{1}{3}$*p*. 22. $7\frac{1}{2}$ da. 23. R31. 14*a*. 24. £1. 8*s*.
25. R168. 26. 11*s*. 3*d* 27. £3. 12*s*. 28. 14*a*. 8*p*.
29. $94\frac{3}{5}$. 30. $21\frac{1}{3}$ md. 31. R937. 8*a*. 32. $17\frac{9}{11}$ days.

33. $16\frac{1}{14}$. **34.** 4618. **35.** $117\frac{1}{3}$. **36.** $391\frac{1}{9}$ yd.
37. $40\frac{10}{11}$. **38.** $12\frac{4}{11}$. **39** $433\frac{1}{3}$ **40.** R36.
41. $190\frac{5}{9}$. **42.** R7. 6a. $6\frac{2}{3}p$ **43.** 15 **44** 12. **45.** R60.
46. 100 grains **47.** $8\frac{8}{11}$ **48** R390 **49.** R1 **50.** 1 lb 8 oz.

Examples 125.

1. 6. **2** 6. **3.** 8 **4** 15. **5.** 10.
6. 11 md. 8 seers **7.** 4 **8** 2 hr 40 min. **9.** 12 oz
10. 9s. **11.** 48 **12** 180 days **13** $45\frac{5}{8}$ days.
14. $41\frac{3}{8}$ days. **15.** 4 **16.** 6 months. **17.** $35\frac{5}{14}$.

Examples. 126.

1. 2. **2.** 5 **3** 3 **4** 7 **5** 50. **6.** $67\frac{1}{2}$.
7. $22\frac{2}{7}$. **8.** 32. **9.** $10\frac{1}{2}$. **10.** 50. **11.** $8\frac{1}{4}$. **12.** $53\frac{1}{3}$.
13. 75 **14.** R4. **15.** $23\frac{1}{3}$. **16.** 60 yd **17.** $7\frac{1}{2}$ lb.
18. 2*s*. 4*d*. **19.** 8 **20.** 10*a*. **21.** $10\frac{2}{7}$. **22.** 15.

Examples. 127.

1. 6. **2** $3\frac{1}{2}$. **3** $11\frac{1}{3}$ **4.** $30\frac{6}{35}$. **5** 24
6. 3. **7.** 16 **8.** $33\frac{2}{13}$. **9.** $26\frac{8}{17}$. **10** 10.
11. R12 3*a*. **12.** R80. **13.** 16 days. **14.** R118. 12*a*.

Examples. 128.

1. R93. 12*a*. **2.** £471 1*s*. **3.** R171. 14*a*. **4.** 10*a*.
5. 2*a*. 8*p*. **6** 3*d* **7.** R2967. 3*a*. **8.** £4000.
9. R1920. **10.** £396 12*s* **11.** R2880. **12.** £180.
13. £722 . 13 4 **14.** 3*p*. **15.** $\frac{1}{40}$. **16.** £3200. **17.** £3000.

Examples 129.

1. $4\frac{4}{5}$ hr. **2.** $1\frac{23}{37}$ da. **3.** $1\frac{47}{153}$ hr **4.** 4 da.; *A* $\frac{2}{3}$, *B* $\frac{1}{3}$, *C* $\frac{1}{15}$.
5. 12 da. **6.** 1 hr. **7.** $7\frac{1}{17}$ min. **8.** $4\frac{1}{2}$ hr.
9. *A*, $20\frac{4}{13}$ da.; *B*, $8\frac{18}{31}$; *C*, $7\frac{19}{33}$. **10.** $2\frac{?}{103}$ da. **11.** 18 da.
12. $13\frac{1}{3}$ da. **13.** 120 da. **14.** $4\frac{4}{5}$ da. **15.** Each in 60 da.
16. [illegible] **17.** [illegible] hr. **18.** 12 hr. **19.** 16.
20. [illegible] **21.** At 10. **22.** 32. **23.** 25 da.
[illegible] 12[illegible] min. **26.** 4 hr. **27.** $56\frac{2}{3}$ da.

Examples. 130.

1. 2 h. $39\frac{17}{34}$ m. P.M. **2.** 2 h. $48\frac{9}{32}$ m. P.M. **3.** 9 P.M., Friday.

4. After 112 da. 12 hr. (true time); first, 7 h. $48\frac{3}{4}$ m. P.M.; second, 8 h. $18\frac{3}{4}$ m. P.M. **5.** 8 h. $47\frac{181}{577}$ m. A.M.

6. The slower must be put on $13\frac{11}{13}$ min.; or the faster put back $13\frac{29}{31}$ min. **7.** 3 P.M., Dec. 3. **8.** 9 min. **9.** $\frac{1}{2}$ min.

10. 4 P.M. **11.** Tuesday, 4 P.M. **12.** $\frac{5}{16}$ min. past 9.

13. Tuesday next, 4 h. $54\frac{1}{6}$ m. P.M. and 4 h. $32\frac{1}{2}$ m. P.M.

14. $10\frac{10}{29}$ min. past 6. **15.** $\frac{1}{2}$ sec. **16.** 1 h. $50\frac{70}{103}$ m. P.M.

17. On March 13, at the same hour at which it was put right.

18. 5 da. ago, at the same hour; after 235 da. at the same hour.

19. $2\frac{2}{3599}$ min.

Examples. 131.

1. (i) $10\frac{10}{11}$ min. past 2; (ii) $27\frac{3}{11}$ min.; (iii) $43\frac{7}{11}$ min.; (iv) 24 min.; (v) $34\frac{10}{11}$ min., and $52\frac{4}{11}$ min.

2. (i) $16\frac{4}{11}$ min. past 3; (ii) $32\frac{8}{11}$ min.; (iii) $49\frac{1}{11}$ min.; (iv) $3\frac{3}{11}$ min., and $29\frac{5}{11}$ min.; (v) $40\frac{4}{11}$ min., and $57\frac{9}{11}$ min.

3. (i) $32\frac{8}{11}$ min. past 6; (ii) $16\frac{4}{11}$ min., and $49\frac{1}{11}$ min.; (iii) no time; (iv) $19\frac{7}{11}$ min., and $45\frac{9}{11}$ min.; (v) $8\frac{8}{11}$ min., and $56\frac{8}{11}$ min.

4. (i) no time; (ii) $16\frac{4}{11}$ min., and $49\frac{1}{11}$ min. past 12; (iii) $32\frac{8}{11}$ min.; (iv) $13\frac{1}{11}$ min., and $52\frac{4}{11}$ min.; (v) 24 min., and $41\frac{5}{11}$ min.

5. (i) $38\frac{2}{11}$ min. past 7; (ii) $21\frac{9}{11}$ min., and $54\frac{6}{11}$ min.; (iii) $5\frac{5}{11}$ min.; (iv) $25\frac{1}{11}$ min., and $51\frac{3}{11}$ min.; (v) $14\frac{2}{11}$ min.

6. (i) $54\frac{6}{11}$ min. past 10; (ii) $5\frac{5}{11}$ min., and $38\frac{2}{11}$ min.; (iii) $21\frac{9}{11}$ min.; (iv) $2\frac{2}{11}$ min., and $41\frac{5}{11}$ min.; (v) $13\frac{1}{11}$ min., and $30\frac{6}{11}$ min.

7. $22\frac{8}{13}$ min. past 2. **8.** $27\frac{543}{871}$ min. past 5.

9. $41\frac{49}{71}$ min. past 5. **10** $4\frac{4}{11}$ min. past 12.

11. $\frac{1}{2}$ min.-div. put back. **12.** Gains $56\frac{8}{77}$ min.

Examples. 132.

1. In $4\frac{2}{5}$ sec. **2.** 417 mi. **3.** At 7·30 P.M.; 300 mi. from Cal.

4. At 5 h. $34\frac{2}{7}$ m. A.M.; $257\frac{1}{7}$ mi. from Cal. **5.** $4\frac{4}{5}$ sec.

6. 36 sec. **7.** $3\frac{1}{2}$ and $1\frac{1}{2}$ mi. per hr. **8.** 1 hr. $26\frac{7}{13}$ min.
9. 150 yd. **10.** 11 h. $38\frac{2}{7}$ m. A. M. **11.** $119\frac{1}{2}$ mi.
12. 12 mi. from Cal. **13.** 7 miles.
14. 5 min. $24\frac{10}{11}$ sec. after *B* starts. **15.** 9 h. $9\frac{3}{13}$ m. A. M.
16. 240 mi. **17.** 6 mi. and 5 mi. per hr. **18.** 7 mi. **18a.** $11\frac{1}{4}$ mi.
19. 9 hr. $37\frac{9}{11}$ min. **20.** 10 hr. 46 min. **21.** 46.
22. 16 min. 42 sec. **23.** 3 hr. 55 min. **24.** 28 min.

Examples. 133.

1. (i) 10 hr. ; (ii) $1\frac{2}{7}$ hr. **2.** (i) $7\frac{1}{2}$ hr. ; (ii) $1\frac{7}{8}$ hr. **3.** $31\frac{1}{2}$ da.
4. 300 da. ; 300 da. **5.** 3 hr. ; 6 hr.

Examples. 134.

1. $5\frac{5}{19}$ min. **2.** $79\frac{1}{11}$ yd. **3.** 80 yd.
4. 9 min. 36 sec. **5.** *C* can give *B* 5 points.
6. *B* wins by 126 yd. 2 ft. and by 1 min. 16 sec.
7. 5. **8.** *C* wins by $60\frac{20}{73}$ yd.
9. *A*, 1 min. $15\frac{163}{176}$ sec. ; *B*, 1 min. $20\frac{1}{2}$ sec. ; *C*, 1 min. 23 sec.
10. *A* wins by $68\frac{28}{33}$ yd. **11.** 9.
12. *A* in $16\frac{24}{125}$ sec. ; *B*, $17\frac{3}{5}$ sec. ; *C*, $18\frac{3}{5}$ sec.
13. 176 yd. **14.** 5.
15. *A* in 15 min. 50 sec. ; *B* in 16 min. 20 sec. ; *C* in 16 min. 40 sec.
16. *C* wins by $\frac{1760}{3741}$ yd.

Examples. 135.

1. $18\frac{1}{80}$. **2.** 6*a*. $10\frac{1}{3}$*p*. **3.** 100. **4.** R2. 4*a*. $6\frac{8}{9}$*p*. **5.** $19\frac{1}{5}$.
6. 1885. **7.** $10\frac{5}{24}$ da. **8.** $3\frac{4}{7}$ da. **9.** 32. **10.** 10*a*.

Examples. 136.

1. 10. **2.** 45. **3.** 264. **4.** 75. **5.** 8. **6.** $10\frac{10}{27}$.
7. R37. 8*a*. **8.** 30. **9.** R24. 4*a*. $10\frac{2}{3}$*p*. **10.** 21 mo.
11. 8. **12.** 6. **13.** $43\frac{1}{3}$ da. **14.** 120.
15. $6\frac{9}{11}$ oz. **16.** 1*s*. 4*d*. **17.** 10*s*. 8*d*. **18.** $8\frac{1}{3}$.
19. 27. **20.** 9. **21.** 25. **22.** 10.
23. $13\frac{1}{2}$. **24.** $4\frac{1}{2}$. **25.** $6\frac{2}{3}$ oz. **26.** £98. 5*s*.
27. 8. **28.** 4. **29.** 7. **30.** 4.

31. 8. **32.** $30\frac{3}{8}$. **33.** R60. 7*a*. $9\frac{11}{31}$*p*. **34.** 75 ac.
35. $19\frac{1}{4}$ oz. **36.** 20. **37.** 3.

Examples. 137.

1. R20. **2.** R3 ; R4. **3.** 180 gr. ; $87\frac{3}{11}$ gr. **4.** R13.
5. R5 ; R20. **6.** 48 da. **7.** 28 da. **8.** $54\frac{6}{11}$ da. **9.** 4 da.
10. A man in $7\frac{1}{5}$ hr. ; a boy, 18 hr. ; a man and a boy in $5\frac{1}{7}$ hr.
11. 6. **12.** 10 hr.

Examples. 138.

1. $\frac{5}{7}$. **2.** $\frac{3}{8}$. **3.** $\frac{6}{11}$ **4.** $\frac{4}{3}$. **5.** $\frac{14}{29}$. **6.** $\frac{25}{36}$.
7. $\frac{2}{3}$. **8.** $\frac{3}{5}$. **9.** $\frac{6}{5}$. **10.** 5 : 4. **11.** 1 : 4. **12.** 1 : 1.
13. 1 : 4 **14.** 7 : 8 is greater. **15.** 18 : 29 is greater.
16. 4 : 5 greatest, 2 : 3 least. **17.** 7 : 11 greatest, 3 : 7 least.
18. Yes. **19.** No. **20.** Yes. **21.** $10\frac{2}{7}$. **22.** $5\frac{1}{3}$.
23. ·0002. **24.** 18 lb. **25.** £1. 6*s*. 8*d*. **26.** 45 men.
27. £2. 5*s*. **28.** 30 hr. **29.** 7*s*. **30.** 14. **31.** 39.
32. 7280. **33.** $\frac{6}{91}$ **34.** $3\frac{3}{4}$. **35.** ·06. **36.** 25.
37. $4\frac{12}{25}$. **38.** 12*a*. 6*p*. **39.** 17 : 10. **40.** 27 : 64.
41. 2 : 1. **42.** 192 : 240 : 280 : 315. **43.** £2. 5*s*. $8\frac{4}{7}$*d*.
44. 18500 oz. **45.** 33 ft. **46.** 15 : 16. **47.** £32.
48. 30 gall., 20 gall. **49.** 40 gall. **50.** 16 : 15.

Miscellaneous Examples. 139.

1. 17. **2.** R204 **3.** $3^2.5.7^2.11^2.13^2$; 5. **4.** $\frac{163}{210}$.
5. R369. 2*a*. 3*p*. **6.** 18. **7.** 9996 and 1020.
8. R65. 15*a*. 6*p*. **9.** 8. **10.** 25. **11.** £269. 1*s*. $9\frac{1}{2}$*d*.
12. 1584 lb. **13.** 3020 men ; 2700 women. **14.** R151. 2*a*.
15. 63 times. **16.** $3\frac{3}{11}$. **17.** 123. **18.** £1. 10*s*. **19.** 84.
20. R8. 2*a*. 6*p*. to each of 5 ; R4. 1*a*. 3*p*. to each of the others.
21. 13. **22.** ·0203125. **23.** $\cdot 01\dot{6}$ **24.** $14\frac{31}{35}$.
25. 6. **26.** 720. **27.** 162 dollars. **28.** $13\frac{1}{3}$ gall.
29. 112 sq. yd. 7 ft. **30.** $4\frac{23}{33}$ hr. **31.** 50 years.
32. 10 seers. **34.** $\cdot 08\dot{3}$. **35.** R110. 4*a*. ; 1 ft. **36.** 3*a*.
37. $\frac{4319}{2038}$. **38.** The first person gains R1. 11*a*. 6*p*. more.
39. 455. **40.** $\frac{80}{81}$; $\frac{1}{161}$. **41.** $1\frac{2}{3}$ ft. **42.** R5888.

43. 14. **44.** 4. **45.** 40 grains. **46.** ·6552.
47. 9600. **48.** R2790. 10*a.* ; $\frac{893}{1152}$. **49.** R14.
50. £22. 18*s.* ; £7. 12*s.* 8*d.* **51.** 42 boys ; 20 fruits. **52.** $\frac{1}{4}$.
53. 4 sq. ft. 18 in. **54.** $13\frac{1}{3}$ da. **55.** R3600.
56. £1. 7*s.* 1*d.* and 4*d.* **57.** 55 min. **58.** 27·i.
59. R1. 10*a.* 6*p.* ; R1. 9*a.* $7\frac{3}{4}$*p.* **60.** $9\frac{3}{4}$ weeks ; £341. 5*s.*
61. 4 gall. **62.** $3\frac{3}{4}$ hr. **63.** 11 P. M.
64. 1 P. M. ; 120 mi. from Cal. **65.** 172800. **66.** 39.
67. 13*s.* $10\frac{1}{2}$*d.* ; $\frac{37}{84}$. **68.** After $12\frac{1}{2}$ min. **69.** R2120.
70. £2. 0*s.* 8*d.* **71.** $2\frac{1}{2}$ mi. **72.** 128.
73. 14 ; 28 ; 42. **74.** 42 ft. **75.** $14\frac{2}{7}$ da.
76. Monday, 12 h. 8 m. P. M. ; 11 h. 56 m. A. M. **77.** 66 yd.
78. R2560. **79.** $59\frac{7}{12}$. **80.** 14 yd. ; 7 yd. ; 2 yd. 2 ft.
81. 1·15 o'clock. **82.** 2250. **83.** $1\frac{1}{2}$ mi. ; 2 hr.
84. 8 mi. per hr. **85.** 16 lb. **86.** $2\frac{8}{11}$ hr. **87.** 1008.
88. 72. **89.** 45. **90.** 6 : 5. **91.** $\frac{7}{1860}$. **92.** 5.
93. $55\frac{1}{2}$ sec. **94.** $20\frac{20}{47}$ yd. **95.** 10. **96.** 29 of wine to 41 of water.
97. *A*, R5. 4*a.* ; *B*, R17. 12*a.* ; *C*, R24.
98. $4\frac{10}{11}$ and $16\frac{4}{11}$ min. past 2. **99.** $30\frac{15}{22}$ sec. **100.** 18.
101. A cow, £1 ; a sheep, 5*s.* **102.** 7 : 17. **103.** $\frac{1}{8}$.
104. $7\frac{1}{3}$. **105.** 4 mi. per hr. **106.** *B* wins by $\frac{1}{24}$ yd.
107. 4 da. **108.** 2 oz. **109.** 2 ga
110. $392\frac{17}{24}$. **111.** 55 min. **112.** 5 min. 15 sec.
113. 152 da. **114.** 4 gall. **115.** £491. 8*s.*
116. *A* in 36 days ; *B*, 48 ; *C*, $28\frac{4}{5}$. **117.** 20 mi. per hr.
118. 360 sec. **119.** 15. **120.** 2 : 1.

Examples. 140.

1. R1. 9*a.*, R3. 2*a.*, R4. 11*a.*, R6. 4*a.*
2. £8. 2*s.*, £6. 15*s.*, £2. 14*s.*, 18*s.* **3.** 7, $4\frac{1}{2}$, $6\frac{2}{3}$, $7\frac{7}{8}$ tons.
4. 75, 100, $112\frac{1}{2}$, 120, 125. **5.** £3, £1. 17. 6. **6.** R106.
7. £66 ; £71. 10*s.* **8.** $100\frac{4}{5}$ lb. **9.** 250 lb. **10.** 50,000.
11. R40, R30, R20. **12.** R12, R16, R8. **13.** R240, R80, R40.
14. R18, R6, R8. **15.** £8, £6. **16.** 12, 10, 8.
17. R6, R10, R5. **18.** 5*s.* $7\frac{1}{2}$*d.*, 7*s.* $3\frac{3}{4}$*d.*, 1*s.* $8\frac{1}{4}$*d.*, 18*s.* 9*d.*

19. Each man 5*s*., each woman 3*s*., each boy 2*s*. **20.** R2. 8*a*.
21. Men 27*s*, women 27*s*., children 11*s*. 3*d*. **22.** £18, £12, £9.
23. $\frac{14}{71}$ cwt. **24.** 20, 30, 40, 50. **25.** 50.
26. 40 rupees, 48 eight-anna pieces, 64 four-anna pieces.
27. Each man R2. 8*a*., each woman R1, each child R$\frac{3}{8}$.
28. $\frac{3}{7}$, $\frac{2}{5}$, $\frac{1}{3}$. **29.** R70 2, R30.
30. The radii are $\frac{1}{\sqrt{3}}$ and $\frac{\sqrt{2}}{\sqrt{3}}$ ft. **31.** 180
32. R25000. **33.** 57.

Examples. 141.

1. R70, R100, R150 **2.** R780, R520. **3** £1200.
4. R4500, R3000, R3000. **5.** R3372. 8*a*. **6.** £480, £360. £240.
7. £17. 10*s*., £15, £12. **8.** R7, R6, R4. 8*a*. **9.** £286, £163. 16*s*.
10. R483$\frac{21}{313}$, R498$\frac{148}{313}$, R218$\frac{166}{313}$. **11.** £100.
12. £366. **13.** R168. 12*a*. **14.** 30.

Examplos 142.

1. In the ratio of 3 to 1. **2.** 8 : 5. **3.** In the ratio of 9 to 11.
4. 197 : 180. **5.** In the ratio of 33 : 2. **6.** 1 : 4.
7. 8½ lb. of each. **8.** 25 md. at R3, 35 md. at R2. 4*a*.
9. $4\frac{4}{9}$ gall. **10.** 20 : 7 ; 5*s*. 1½*d*. **11.** In proportion of 3, 3, 2, 2.
12. In proportion of 1, 1, 5. **13.** 10 gall.
14. In proportion of 4, 6, 9. **15.** In proportion of 52, 78, 51. 68.

Examplos. 143.

1. 3. **2.** $13\frac{5}{6}$. **3.** $7\frac{4}{5}$. **4.** 4·34. **5.** $11\frac{1}{5}$. **6.** R4. 8*a*.
7. 125. **8.** £2 . 19 . $4\frac{4}{5}$. **9.** 10 st. **10.** R4 . 8 . $9\frac{3}{5}$.
11. $8\frac{2}{5}$ mi. **12.** $10\frac{1}{4}$ st. **13.** 14 yr. **14.** 43 yr.
15. $8\frac{1}{3}$ st. **16.** 11 yr. **17.** R5. 11*a*. **18.** R7. **19.** 63°, 75°.

Examples. 144.

1. $\frac{1}{8}$. **2.** $\frac{1}{3}$. **3.** $\frac{1}{400}$. **4.** $\frac{3}{800}$. **5.** $1\frac{1}{4}$. **6.** R35.
7. £10 10*s*. **8.** 3*s*. **9.** 1218. **10.** $\frac{9}{80}$ sq. in.
11. 4 cwt. 1 qr. **12.** R750. **13.** 35929.
14. £600. **15.** R51 . 15 . $7\frac{1}{3}$. **16.** £450.

Examples. 145.

1. 25 p. c. 2. $16\frac{2}{3}$ p. c. 3. $3\frac{1}{3}$ p. c. 4. 40 p. c.
5. $42\frac{6}{7}$ p. c. 6. 35 p. c. 7. $88\frac{8}{9}$ p. c. 8. $19\frac{19}{89}$ p. c.
9. $468\frac{3}{4}$ p. c. 10. 138 p. c. 11. 50 p. c. 12. 20 p. c.
13. 20 p. c. 14. $57\frac{1}{7}$ p. c. 15. 210 p. c. 16. 50 p. c.
17. $87\frac{41}{57}$ p. c. 18. 24 p. c. 19. $12\frac{1}{2}$ p. c.
20. Nitre 75 p. c., sulphur 10, and charcoal 15. 21. $8\frac{1}{3}$ p. c.

Examples. 146.

1. 220. 2. 1200. 3. 25. 4. 10800. 5. 100.
6. $1296\frac{8}{27}$. 7. R4875. 8. R5000. 9. 13000. 10. R78. 2a.

Miscellaneous Examples. 147.

1. 10a. 2. R8000. 3. R$4545\frac{5}{11}$. 4. 128. 5. R$1531\frac{11}{19}$.
6. 35 p. c. 7. $54\frac{2}{7}$ p. c. 8. $2\frac{94}{847}$ p. c. decrease. 9. 50 lb.
10. $9\frac{1}{11}$ p. c. 11. $18\frac{2}{11}$ p. c. 12. $9\frac{1}{11}$ p. c.

Examples. 148.

1. R175. 2. £245. 3. R$75\frac{5}{8}$. 4. R7003. 2a.
5. R28000. 6. £$914\frac{2}{7}$. 7. R3000. 8. £101. 10. $7\frac{1}{5}$.
9. R10000. 10. £260. 11. £$5154\frac{62}{87}$; £$154\frac{62}{87}$

Examples. 149.

1. 25 p. c. 2. 25 p. c. 3. 25 p. c. 4. $33\frac{1}{3}$ p. c.
5. $8\frac{1}{3}$ p. c. loss. 6. $71\frac{29}{51}$ p. c. gain. 7. $33\frac{1}{3}$ p. c.
8. R80 ; 1a. $10\frac{4}{7}$p. 9. 1s. $5\frac{1}{4}$d. 10. 12. 11. 9s. $4\frac{1}{2}$d.
12. 2s. $3\frac{33}{53}$d. 13. $12\frac{1}{2}$ p. c. 14. $2\frac{2}{15}$a. 15. R500.
16. 8 md. 17. 143 for R12. 18. R$2320\frac{5}{8}$. 19. R320.
20. $\frac{2}{7}$s. 21. R2 . 0 . $4\frac{1}{2}$. 22. 8. 23. 6 p. c. gain.
24. $\frac{1}{2}$ p. c. gain. 25. 50 p. c. 26. $2\frac{18}{41}$d. 27. Loses 16 p. c.
28. 17 p. c. 29. $26\frac{10}{17}$ p. c. 30. $16\frac{2}{3}$ p. c. 31. R150.
32. R$22\frac{2}{9}$. 33. 25 yd. 34. Gains $30\frac{1}{26}$ p. c.
35. 4 for 3a. ; 5 : 12. 36. 1 lb. to 2 lb. 37. 2a. 3p.
38. $17\frac{1}{2}$ p. c. ; 7 : 1. 39. R23 . 5 . 4. 40. 19 : 12.
41. 1 : 2. 42. 21 p. c. 43. R460. 44. $33\frac{1}{3}$ p. c.

Examples. 150.

1. R7. 4*a*. 2. R21. 6*a*. 3. R45.
4. R263 . 10 . 9. 5. R11 . 12 . 6. 6. R270.

Examples. 151.

1. R24. 2. £60. 3. R315. 4. £57 . 12*s*.
5. R222. 12*a*. 6. £112. 7. R40 . 13 . $8\frac{19}{25}$; R536 . 1 . $8\frac{19}{25}$.
8. £32 . 10 . 6 ; £357 . 15 . 6. 9. R108 . 5 . $7\frac{17}{25}$; R334 . 1 . $4\frac{17}{25}$.
10. R285. 11. £372. 8*s*. 12. R440 . 8 . $4\frac{1}{2}$.
13. £763 . 13 . $0\frac{3}{25}$. 14. £406 . 4 . $1\frac{257}{320}$. 15. £226 . 1 . 11.

Examples. 152.

1. R33 . 5 . 4. 2. £100. 3. £157 . 10*s*.
4. R5 . 12 . 6. 5. R2 . 0 . 3. 6. R3 . 14 . 7.

Examples. 153.

1. £2. 8*s*. 2. R20. 4*a*. 3. R4 . 13 . $1\frac{23}{25}$.
4. £5 . 4 . $6\frac{15}{73}$. 5 R6 . 14 . $1\frac{671}{1168}$. 6. R9 . 14 . $7\frac{13}{125}$.

Examples. 154.

1. $2\frac{1}{2}$. 2 $3\frac{1}{4}$. 3. $3\frac{11}{36}$. 4. $3\frac{9}{25}$.
5. 5. 6 $3\frac{1}{3}$. 7. $2\frac{3}{4}$. 8. 6*p*.

Examples. 155.

1. 3 yr. 2. $3\frac{1}{3}$ yr. 3. $3\frac{1}{2}$ yr. 4. 4 yr. 9 mo.
5. 2 yr. 3 mo. 24 da. 6. 97 days. 7. 64 yr. 8. 3 yr.
9. 5 yr. 10. 15th April. 11. 16 mo.

Examples. 156.

1. R750. 2. R4266 . 10 . 8. 3. £170 . 6 . 3. 4. £1050.
5. R400. 6. R730. 7. R800. 8. R150.
9. R265. 10. £33 . 13 . 4. 11. R672 . 4 . 4. 12. £1022 . 14 . 7.

Miscellaneous Examples. 157.

1. $6\frac{1}{4}$. 2. R500. 3. R570. 4. 3 yr. 5. 10 yr.
6. 6 p. c. 7. R9733 . 5 . 4. 8. R400 ; $7\frac{1}{2}$. 9. $8\frac{8}{19}$ yr.
10. R533 . 5 . 4. 11. £190. 12. £30000. 13. R19200. 14. 40 yr.

Examples. 158.

1. R41. 2. R42 . 6 . 11. 3. R38 . 6 . 6. 4. R141 . 2 . 8
5. £731 . 3 . 3. 6. £343 . 4 . 5. 7. £641 . 6 . 3. 8. £260 . 9 . 1.
9. R14 . 2 . $2\frac{22}{25}$. 10. £31 . 18 . 9 to the nearest penny.

Examples. 159.

1. R1102. 8*a*. 2. R327 . 13 . 1. 3. R772 . 4 . 2.
4. R855. 14*a*. 5. R2184 . 13 . 4. 6. R4328 . 7 . 7.
7. R1 . 0 . 10. 8. R11 . 1 . 7. 9. R3278 . 2 . 11.
10. R375 . 3 . 11. 11. £90 . 14 . 1 to the nearest penny.
12. £120. 13. £250. 14. £3125.
15. £815 . 3 . 3 to the nearest penny.
16. 15*s*. to the nearest penny.

Miscellaneous Examples. 160.

1. R2·432. 4. R625. 5. R3310. 2*a*.
6. 85184. 7. R10000. 8. R5000.

Examples. 161.

1. R170. 2. R1250. 3. R3562. 8*a*. 4. £1337. 10*s*.
5. £1416 . 13 . 4. 6. £1005 . 6 . 8. 7. R1600.
8. R182. 8*a*. 9. R20000. 10. £1000.

Examples. 162.

1. R5. 4*a*. 2. R80 . 3 . 4. 3. R151. 14*a*.
4. R105 . 6 . 8. 5. £20 . 4 . $8\frac{1}{2}$. 6. £17 . 8 . $2\frac{22}{81}$.
7. £4 . 2 . 4. 8. £1. 15*s*. 9. R708. 12*a*.
10. R482 . 14 . 8. 11. R1077 . 8 . 6. 12. £38 . 8 . 9.

Examples. 163.

1. 2 years hence. 2. $3\frac{17}{36}$ yr. 3. $3\frac{1}{2}$ yr. 4. 9 mo.
5. $2\frac{1}{2}$ yr. 6. $4\frac{1}{4}$ yr. 7. 3 mo.

Examples. 164.

1. 20 p. c. 2. $2\frac{1}{2}$ p. c. 3. $5\frac{1}{2}$ p. c. 4. $2\frac{3}{4}$ p. c.
5. [illegible] p. c. 6. 5 p. c. 7. $3\frac{1}{2}$ p. c.

Examples. 165.

1. R8134. 8*a*. 2. R53903 . 10 . 8. 3. £574 . 3 . 4.
4. 4 yr. 5. 19 mo. 6 $3\frac{1}{2}$ p. c. 7. R600. 8. R2800.
9. R450 ; $6\frac{1}{4}$ p. c. 10. £200 ; 5 yr. 11. R$134\frac{44}{81}$.
12. £858 . 6 . 8. 13. *B*'s offer. 14. R$60\frac{40}{41}$.
15. 50 : 51 ; R$49\frac{1}{51}$. 16. 20 p. c. 17. R$91\frac{2}{3}$.
18. £$17\frac{13}{41}$. 19. £188 . 13 . $5\frac{1}{4}$. 20. $12\frac{1}{2}$.
21. £375. 10*s*. 22. R7128 . 11 . 10 to the nearest pie.

Examples. 166.

1. R2 . 8 . 10 2. £247. 10*s*. 3. £2. 8*s*. 4. R88. 13*a*.
5. $1\frac{18}{459}a$. 6 $1\frac{24}{29}s$. 7. R9504. 8. R337. 8*a*.
9. 20 p. c. 10. $16\frac{2}{3}$ p. c. 11. $12\frac{1}{2}$ p. c. 12. $33\frac{1}{3}$ p. c.

Examples. 167.

1. 7 mo. 2. $2\frac{9}{11}$ mo. 3. 8 mo. 4. 6 mo. 5. 9th June.

Examples. 168.

1. R1900. 2. £242 . 16 . 3. 3. R5034. 6*a*. 4. $93\frac{5}{8}$.
5. $106\frac{3}{8}$. 6. R1500. 7. R4500. 8. £7440. 9. R70.
10. £22. 10*s*. 11. £1248. 12. £$5177\frac{7}{9}$. 13. £5300.

Examples. 169.

1. R70 2. R1641 . 5 . 3. 3. £40,000. 4. R270.
5. £921. 4*s*. 6. R779 . 2 . 8. 7. R6. 4*a*. 8. 17.
9. 105. 10. £20 increase. 11. R3750 stock ; R11. 4*a*. increase.
12. R34 decrease. 13. R20 gain. 14. No alteration.
15. £30,500. 16. R22,500. 17. R7200.
18. $93\frac{3}{4}$. 19. $129\frac{7}{8}$. 20. $78\frac{3}{8}$.

Examples. 170.

1. $4\frac{3}{8}$ p. c. 2. $4\frac{52}{187}$ p. c. 3. $3\frac{3}{4}$ p. c. 4. $38\frac{1}{8}$. 5. $72\frac{8}{11}$.
6. $74\frac{7}{8}$. 7. 99. 8. $86\frac{1}{3}$. 9. $4\frac{47}{138}$ p. c. 10. The latter.
11. The former. 12. $\frac{5}{11}$ p. c. 13. R7040. 14. £3400.

Miscellaneous Examples. 171.

1. $\frac{40}{171}$ p. c. 2. $2\frac{1}{2}$ p. c. 3. The former. 4. £32. 5*s*.
5. $77\frac{1}{2}$. 6. 190. 7. £1800 ; 2 years sooner.

8. R90,600. **9.** R1824. **10.** 91. **11.** $82\frac{1}{4}$.
12. R840. **13.** 108. **14.** £9880. **15.** R30,000.
16. £4. 16*s*.; 35 : 34. **17.** 2261 : 2260. **18.** R20800.
19. 10. **20.** R1000 and R2000. **21.** £400, £1200.
22. R3200. **23.** $3\frac{4}{45}$ p. c. **24.** R100. **25.** R2700.
26. £242914$\frac{242}{247}$. **27.** £75,000. **28.** $100\frac{20}{21}$.

Examples. 172.

1. £275 . 15 . 5. **2.** R3705 . 7 . 6. **3.** 360. **4.** £4 . 17 . 4.
5. R2 . 13 . 4 per dollar. **6.** 110. **7.** R$1\frac{1}{8}$. **8.** 14.
9. R25. 15*d*. **10.** Advantageous through London.
11. £12 . 18 . $7\frac{13}{23}$. **12.** I lose 10 p. c. **13.** 8*s*. 2*d*.
14. £83 . 6 . 8. **15.** £56. 5*s*. **16.** R1 = 1*s*. 8*d*. **17.** £80.
18. £4687. 10*s*. **19.** Gains £11. 5*s*. **20.** 1*s*. 4*d*. per rupee.
21. 1 Gold Mohur = ·71...eagle. **22.** 1 Napo. = 8·55 rupees.
23. R1. 8*a*. **24.** 2*s*. 1*d*. **25.** One of the former = 2 of the latter.

Examples. 173.

1. 30. **2.** R94. **3.** R70. **4.** 3. **5.** $3\frac{1}{2}$ mi.
6. R18. **7.** 5*s*. 10*d*. **8.** Tea 2*s*., coffee 1*s*. per lb.
9. Tea 2*s*., sugar 6*d*. per lb. **10.** 2 and 5. **11.** £900 and £300.
12. 25. 30 and 35 years. **13.** 20, 10 and 15 years.
14. *A* R51, *B* R18, *C* R8. **15.** R150. **16.** R$342\frac{6}{7}$.
17. 95, 60, **18.** 40, 60. **19.** 450, 300. **20.** R6. 4*a*.
21. 5*a*. **22.** 1 md. ; 5 md., 3 md. **23.** $40\frac{5}{22}$ mi. per hr.
24. $24\frac{507}{682}$ mi. **25.** 1122 ft. **26.** $15\frac{99}{500}$ min. **27.** $9\frac{87}{89}$ min.
28. 40. **29.** 20. **30.** 70 oz. **31.** 12 gr.
32. 11 oxen, 24 sheep. **33.** £8750. **34.** 20 years'.
35. 3 p. c. **36.** $3\frac{1}{3}$ weeks. **37.** 19. **38.** 15 lb. 10 oz.
39. 44 days ; 2 : 1. **40.** 200 cu. ft. **41.** 3 hours.
42. 3 hours. **43.** 65 gallons ; 13 hours.

Examples for Exercise. 174a.

1. Ten billion, thirty thousand two hundred million, seven hundred and twenty thousand, and twenty-one.
2. 48910. **3.** 473379. **4.** $5^2 . 11^2 . 17$.

5. $\frac{13}{14}$. **6.** 23·0424 ; 22·9596. **7.** R4 . 7 . 9.

8. Three hundred and twenty crores, one lac, three thousand, one hundred and two.

9. 10091401. **10.** R2 . 7 . 3. **11.** 37. **12.** $1\frac{3}{4}$.
13. ·0001596 ; ·0051472. **14.** $1\frac{1}{2}d$. **15.** 18508984.
16. 49110419796. **17.** 17*s*. 9*d*. **18.** 48345. **19.** $5\frac{134}{459}$.
20. ·7045. **21.** $\frac{5}{12}$. **22.** CMXLIV ; 499.
23. 33211521848. **24.** 921. **25.** $1\frac{1}{2}$. **26.** 153·41134.
27. ·02$\dot{6}$. **28.** 15. **29.** 765. **30.** 9. **31.** 32953856 dr.
32. $\frac{15}{64}$. **33.** $\frac{53}{66}$. **34.** 212. **35.** £1. 3*s*. $5\frac{1}{4}d$. **36.** 13440.
37. R8. 3*a*. $2\frac{2}{5}p$. **38.** $\frac{1}{160}$. **39.** $\frac{1001}{2464}$. **40.** 3·0688259...
41. $\frac{6068}{24975}$. **42.** R3. 12*a*. **43.** 2. **44.** $142114\frac{1}{2}$
45. $\frac{3}{11}$, $\frac{2}{5}$, $\frac{27}{70}$. **46.** $1\frac{7}{9}$. **47.** 4. **48.** ·0$\dot{8}$.
49. 7. **50.** 324. **51.** 11. **52.** $3\frac{5}{6}$. **53.** 700310.
54. 1·2375. **55.** 12556875*d*. **56.** 1 min. 30 sec.
57. 124727. **58.** R16. 13*a*. 3*p*. **59.** $\frac{3}{11}$.
60. 3 po. 4 yd. 2 ft. 3 in. **61.** 9 ; 7. **62.** 424·8936.
63. 14. **64.** 4536360. **65.** 52084. **66.** R110328. 1*a*. 6*p*.
67. $22\frac{2}{3}$. **68.** $\frac{9}{4}$. **69.** $3\frac{3}{8}$. **70.** 4828·04...
71. 5456. **72.** 340 po. 5 yd. 1 in. **73.** R4[illegible]6. 9*a*.
74. $\frac{1}{18}$. **75.** 11*s*. $8\frac{3}{4}d$. **76.** 42·6. **77.** ·7$\dot{0}\dot{9}$. **78.** 137.
79. R1. 7*a*. 4*p*. **80.** Saturday. **81.** $\frac{9113}{50580}$. **82.** $\frac{1}{7}$.
83. $\frac{5}{7}$. **84.** 43·$\dot{3}$. **85.** 729. **86.** £125. 5*s*. **87.** $\frac{3}{4}$.
88. 9405. **89.** 120·712. **90.** $7702\frac{1}{8}$ in.
91. 934·12 sq. yd. **92.** R3. 8*a*. **93.** 5 and 7. **94.** $2\frac{29}{30}$.
95. 275 times ; rem. ·003. **96.** ·3125. **97.** 2940000.
98. 9, 6 and 4 times. **99.** 326764. **100.** 4*s*.
101 $1\frac{73}{182}$. **102.** $\frac{11}{16}$. **103.** ·4$\dot{4}$61538$\dot{8}$. **104.** 112·$\dot{4}$.
105. 21 yd. 2 ft. $2\frac{5}{8}$ in. **106.** 1753. **107.** $\frac{1}{5}$.
108. 12*a*. **109.** ·000000$\dot{1}$4285$\dot{7}$. **110.** ·00759... **111.** ·$\dot{8}$.
112. $\frac{6}{87}$. **113.** 1296. **114.** 1386 sq. yd. 3 ft. 96 in.
115. $\frac{3}{5}$. **116.** $3\frac{1}{3}$. **117.** 8. **118.** R1. 8*a*. 8*p*. **119.** 220.
120. 48. **121.** 2*s*. $8\frac{1}{2}d$. **122.** $1\frac{1}{10}$. **123.** 13.
124. ·330$\dot{5}$. **125.** 3·$\dot{4}$6153$\dot{8}$. **126.** £182. 7*s*. 2*d*. **127.** 13.
128. Wednesday. **129.** 53. **130.** $4\frac{4}{15}$. **131.** 20.

132. ·0432. **133.** 3840. **134.** $2^2.3.5.7.673$; 3.7.19.101 ; G. C. M. 21 ; L. C. M. $2^2.3.5.7.19.101.673$.
135. 26. **136.** 1. **137.** $\cdot\dot{0}5752\dot{8}$. **138.** $\frac{1}{16}$.
139. 4288·179204. **140.** 250 times.

Examples for Exercise. 174b.

1. 3210 ; 1023. **2.** 12. **3.** 3. **4.** $16\frac{2}{3}$ min.
5. $46\frac{2}{3}$. **6.** $\frac{1}{3}$. **7.** 5 p. c. **8.** 4, 7.
9. 4725. **10.** 1050 sq. yd. **11.** 6 h. $27\frac{9}{23}$ m. P. M.
12. R46. 4*a*. **13.** 3·2804. **14.** 4. **15.** 137.
16. 1250 ; ·0125 ; ·0000000125. **17.** R5. 10*a*.
18. Monday 8 P. M. ; $\frac{3}{16}$ min. to 6. **19.** 10*s*. ; 6*s*. 8*d*. ; 2*d*.
20. $\frac{67}{135}$. **21.** 17*s*. 6*d*. **22.** 1855. **23.** $8\frac{880}{4249}$.
24. 300 sq. yd. **25.** 8 hr. **26.** £22. 8*s*. **27.** 169 : 191.
28. $9\frac{1}{11}$ p. c. **29.** 999976 ; 100141. **30.** 172.
31. 19251, 18261, 17271, 16281, 15291, 15201, 14211, 13221, 12231, 11241, 10251. **32.** $3\frac{1}{2}$ hr. **33.** R9963. **34.** 11 : 9.
35. $33\frac{1}{3}$. **36.** 5. **37.** 14. **38.** R750. **39.** 7 h. 34 m. P. M.
40. £419 . 19 . 3. **41.** 401 : 544. **42.** 4 yr. **43.** 150.
44. $\frac{8}{11}$. **45.** 1015. **46.** $3\frac{1}{3}$ days. **47.** 9 days. **48.** 16 : 65.
49. £264. 6*s*. 8*d*. **50.** 14. **51.** 80. **52.** R156.
53. 1 hr. **54.** 70. **55.** 83 : 92 ; 92 : 153. **56.** £4800.
57. 429. **58.** $\cdot 0\dot{2}$. **59.** $11\frac{1}{4}$ gallons. **60.** 11 P. M. **61.** 12 da.
62. In the first vessel ratio of wine to water is 1729 : 271 ; in the second 271 : 1729. **63.** £4840, £4400, £4000. **64.** 20.
65. 7·875. **66.** 453750 tons. **67.** 45 days. **68.** 440 mi.
69. 7 : 1. **70.** $53\frac{1}{3}$. **71.** 200. **72.** 120. **73.** 26.
74. $17\frac{1}{2}$ mi. and $9\frac{1}{2}$ mi. per hour. **75.** 1*s*. $10\frac{1}{2}$*d*.
76. Each man £3. 15*s*. ; each woman £2. 10*s*. ; each child £1. 5*s*.
77. 4 mo. hence. **78.** 250. **79.** 388 ; 11·32 gr.
80. R19. 8*a*. **81.** Loses $1\frac{440}{441}$ min. **82.** 20 hr. 16 min.
83. 1200. **84.** £276 . 6 . 1. **85.** 8184 or 7434.
86. £10. 8*s*. **87.** 126. **88.** 12 hr.
89. $18\frac{4}{7}$ days ; on the supposition that they work 13 hours a day.
90. *A* £540, *B* £360, *C* £240. **91.** R$621\frac{9}{11}$. **92.** R500.

93. 61000. **94.** 24 yd. per min. **95.** 9 hr.
96. $113\frac{1}{623}$ gr. **97.** R2. 13*a*., R4. 8*a*. **98.** 10 for a rupee.
99. £1033. **100.** 128.5016.... **101.** $\frac{1}{2}$ in.
102. The clock ought to have been set at 5 h. $30\frac{3175}{8161}$ m. P. M.
103. 150 mi. **104.** *A*, R48 ; *B*, R40 ; *C*, R35. **105.** R26.
106. 63. **107.** $\frac{875}{972}$. **108.** 16 ft. **109.** $12\frac{1}{8}$ hr. ; *A*, $4\frac{4}{5}$; *B*, $5\frac{1}{5}$.
110. R1. 8*a*. **111.** 4*a*., 8*a*., R1. 8*a*., R4. 8*a*., R13. 8*a*.
112. R$24\frac{7}{10}$. **113.** R660. **114.** R24000. **115.** 73 times.
116. $5\frac{1}{7}$ miles from *P*. **117.** 10*a*. **118.** *A*'s $1\frac{3}{5}$ oz., *B*'s 2 oz.
119. R10. **120.** £280. **121.** ·0218... **122.** 2 ft.
123. $7\frac{9}{13}$ yd. **124.** R9. 7*a*. 3*p*. **125.** 40. **126.** R3. 2*a*.
127. 46. **128.** ·575. **129.** £12. 10*s*. **130.** $5\frac{8}{11}$ days
131. $4\frac{1}{6}$ ft. **132.** 8 ft. **133.** Will lose 7 p. c.
134. 120. **135.** $4\frac{1}{8}$. **136.** 15 yd. **137.** $1\frac{8}{28}$ hr.
138. £48. 15*s*. **139.** 35, 15, 10, 25. **140.** $47\frac{1}{17}$ p. c.
141. R5. **142.** 576.0297502224. **143.** 50 times.
144. They will run a dead heat. **145.** 25. **146.** 9.
147. £10. **148.** 3 gallons. **149.** £30 . 14 . $8\frac{2}{3}$. **150.** 3 ft.
151. $23\frac{1}{3}$ days. **152.** 43 wk. 1 da. 2 hr. **153.** 6 ft., 8 ft.
154. Loses $53\frac{1}{8}$ p. c. **155.** 78. **156.** £8. 6*s*. **157.** 121.
158. $21\frac{3}{7}$ min. **159.** R105000. **160.** $6\sqrt{2}$ in., $8\sqrt{2}$ in. **161.** $12\frac{1}{2}$.
162. 42 gallons. **163.** 279 ; $\frac{8}{9}$. **164.** Breadth, 6 yd. ; height, 5 yd.
165. $25\frac{15}{22}$ min. **166.** R67. 8*a*. **167.** 224, 336, 420. **168.** $54\frac{20}{81}$.
169. 72. **170.** $\frac{14}{153}$. **171.** 4 hr. **172.** $21\frac{2}{3}$ hr.
173. 66 min. **174.** *A* must pay 1*s*. 3*d*. and *C* 1*s*. 6*d*. to *B*.
175. £40. **176.** 11. **177.** £2359. 15*s*. $2\frac{86}{187}$*d*. **178.** 1200.
179. 36 mi. and 24 mi. per hour. **180.** $2333283\frac{1}{3}$ francs.
181. £1327. 10*s*. **182.** 12. **183.** $2313\frac{15}{31}$. **184.** ·1115718.
185. $217\frac{1}{2}$ ft. ; 242 times. **186.** $11\frac{1}{3}$. **187.** 3. **188.** £75.
189. The former ; customer loses 2·05 oz. in 1 lb.
190. 58 miles. **191.** 79 wk. 1 da. 22·83 hr. **192.** $263\frac{3}{11}$.
193. $3\frac{2}{47}$ days. **194.** £10. **195.** R300. **196.** 6800 ; 7221.
197. 20th Oct. 1855. **198.** 780 ac., 468 ac., 520 ac.
199. 3 times. **200.** 3426 yd. **201.** (i) 40 ; (ii) 60 ; (iii) 80.
202. *A*, R$2476\frac{4}{21}$; *B*, R$1523\frac{17}{21}$. **203.** $99\frac{5}{16}$; £$176\frac{48}{97}$.

204. $1\frac{3}{4}d$. **205.** ·125. **206.** 3175. **207.** *C* wins by $\frac{880}{3741}$ yd.
208. 19 ac. **209.** R345. **210.** R54. 14*a*. 4*p*.; $31\frac{47}{106}$ p. c.
211. 14*s*. $7\frac{3}{4}d$.; 9*d*. **212.** ·346574. **213.** 1 min. $51\frac{1}{2}$ sec.
214. 60 days. **215.** £606. **216.** After 6 months.
217. £15400. **218.** 2*s*. $2\frac{2}{3}d$. **219.** $1\frac{347}{1285}$.
220. 5000 sq. ft. **221.** $322\frac{2}{3}$ yards. **222.** 29040 ft.
223. R76. **224.** Gains R$25\frac{805}{833}$. **225.** R550. 13*a*. 4*p*.
226 *A*, $1\frac{1}{18}$ of a chest; *B*, $\frac{9}{10}$; *C*, $\frac{1}{30}$. **227.** 17 in.
228. 22 yd. **229.** $43\frac{1}{25}$. **230.** *A*, R76 : *B*, R76 ; *C*, R40.
231. R770 ; 1. **232.** 10. **233.** £860. 3*s*. $11\frac{1}{2}d$.
234. 6 yd., 6 yd., 3 yd. **235.** After 9 min. **236.** 10.
237. 1 lb. to 2 lb. **238.** 12 ; R1460. **239.** R411. 12*a*.
240. 3*s*. $8\frac{985}{1008}d$. **241.** 7 in. each way ; 7776.
242. 2 min. $27\frac{3}{11}$ sec. ; 1080 yd. **243.** 10.
244. Better 20 lb., worse 40 lb. **245.** £500. **246.** 1152.
247. £2364. 12*s*. $4\frac{1}{2}d$. **248.** 2 ft. **249.** *B* wins by 88 yd.
250. R18. **251.** 12 bus., 12 bus., 36 bus.
252. R$5\frac{130}{359}$ decrease. **253.** R4. 3*a* $1\frac{1}{3}p$. **254.** $10\frac{13}{27}$. **255.** 250 lb.
257. $13\frac{1}{2}$ days. **258.** 3 : 2, (by volume). **259.** R30780.
260. R276. 1*a*. 6*p*. **261.** 5*a*. $7\frac{4}{5}p$.; R5498. 7*a*. **262.** 72 yd.
263. 1 min. **264.** R$43\frac{31}{35}$. **265.** 80 lb. **266.** R1726. 10. 8.
267. 4*a*. 3*p*. gain. **268.** £1123 . 15 . 2. **269.** 59 sq. ft. 21 in.
270. 39 yd. **271.** $10\frac{1}{8}$ da. ; $4\frac{73}{243}$ cu. ft. **272.** 65.
273. R95197. 2*a*. $1\frac{13}{83}p$. **274.** 2*s*. 3*d*. **275.** 6*p*. **276.** 12 yd.
277. 3 da. **278.** 27 da. **279.** 2 st. 7 lb. **280.** R16500.
281. $31\frac{3}{11}$ mi. **282.** 64. **283.** 9 cu. ft. $1397\frac{1}{3}$ in. **284.** $1\frac{1}{2}$ hr.
285. 27. **286.** 40 yr. **287.** 92. **288.** 60.
289. £1508. 15*s*. $7\frac{119}{160}d$. **290.** 2399 lb. $7\frac{53}{193}$ oz. **291.** 160 yd.
292. $4\frac{4}{135}a$. **293.** 1000 yd. **294.** 17000 : 18067.
295. $3\frac{1}{3}$ pice. **296.** £1668. 7*s*. $1\frac{141}{176}d$. **297.** R2 . 9 . 8.
298. $5\frac{1}{7}$ da. **299.** 49. **300.** $26\frac{6}{19}$. **301.** £89 . 8 . 9.
302. 9. **303.** R370. **304.** 161 sq. ft. $21\frac{3}{5}$ in. **305.** 25 mi.
306. 2176. **307.** R1500. **308.** £1350. **309.** R2. 15. $7\frac{1}{5}$.
310. 14·5. **311.** 2 in. **312.** 5 min. ; $\frac{1}{4}$ mi. **313.** 68.
314. $10\frac{480}{5601}$ p. c. increase. **315.** 12 p. c. **316.** 4 yd.

317. $933\frac{1}{3}$ lb. **318.** $49\frac{1}{2}$ min. **319.** 18 da. **320.** $33\frac{1}{3}$.
321. R44000 decrease. **322.** R$1705\frac{115}{197}$; £$173\frac{67}{121}$. **323.** 1.
324. $\sqrt[3]{3}$, $\sqrt{2}$, $\frac{4}{3}$. **325.** Faster 99 yd.; slower 77 yd.
326. £1 . 18 . 4. **327.** Just passes. **328.** R6 . 8 . $11\frac{4}{16}$.
329. $4\frac{16}{21}$. **330.** R2. 3*a*. **331.** £900. **332.** $5\frac{5}{143}$ mi.
333. $2\frac{9}{20}$. **334.** 72 gall. **335.** $4\frac{1}{2}$ p. c. **336.** 1*s*. 8*d*.
337. 9*a*. 3*p*. **338.** 144; 1*a*. **339.** 22 mi. **340.** $4\frac{1}{3}$.
341. R$9230\frac{10}{13}$. **342.** £7995. **343.** 1*s*. $9\frac{21}{100}$*d*. **344.** 5*a*. 4*p*.
345. £150. 15*s*. **346.** 80 min. **347.** 2601. **348.** R$1925\frac{4739}{5074}$.
349. £1073. 4*s*. 0·6560736*d*. **350.** R30.

Problems. 175.

1. 942. **2.** 10*d*. **3.** $11\frac{9}{41}$ in. **4.** 1083.
5. 80 guineas, 128 half-crowns. **6.** $\frac{1}{10}$. **7.** 132. **8.** £275.
9. $6\frac{1}{4}$; $156\frac{1}{4}$. **10.** 223·358...; 20·057...oz. **11.** $34\frac{3}{8}$.
12. The latter. **13.** 3*s*. $11\frac{3}{26}$*d*. **14.** 15*s*. $11\frac{1}{4}$*d*., 15*s*. 10*d*., 15*s*. 9*d*.
15. 3456, 2304. **16.** 126 qt. **18.** R5, R3, R2. **19.** 2632.
20. 3. **21.** 36. **22.** 424. **23.** 60. **24.** $1\frac{169}{240}$ oz.
25. 120000. **26.** 11960 sq. yd. 4 ft. 20·41 in.
27. 10 ft. **28.** 10*a*. 8*p*. **29.** 1319·472 ft. **30.** $33\frac{1}{3}$ lb.
31. 8*s*. **32.** R1·025... **33.** 395. **34.** $46\frac{2}{3}$ hr.
35. R1026. **36.** 6 hr. 59 min. 15 sec. **37.** 54 times.
38. 11 days. **39.** *B*; $\frac{1}{312}$. **40.** 13. **41.** 50. **42.** $\frac{8}{11}$ mi.
43. 1 mile 980 yards; $13\frac{83}{88}$ miles. **44.** $2\frac{179}{210}$ hr. **45.** £20.
46. $36\frac{2}{3}$ mi. per hr.; 8 h. 37 m. A. M. **47.** $29\frac{19}{28}$ mi., $15\frac{3}{22}$ mi.
48. $9\frac{93}{226}$ mi. per hr. **49.** $10\frac{5}{8}$ mi. **51.** 115 min.
52. 167 min. **53.** 25 mi. **54.** 11-30 A. M.
55. In 10 min. more. **56.** *A* £162, *B* £118, *C* £104.
57. *A* £1296, *B* £1872, *C* £1044. **58.** 30. **59.** 3.
60. R720, R1280. **61.** $\frac{35}{71}$. **62.** 11, 22 and 33 days.
63. Tea 1*s*. $5\frac{1}{2}$*d*., coffee 5*s*. 10*d*. **64.** 30 and 18.
65. 8 and 12. **66.** 2·20 lb. **67.** 10 gall.
68. Man R250, each woman R62. 8*a*., each child R15. 10*a*.
69. R24, R15, R1. **70.** 30 yr. and 25 yr. **71.** 10 p. c.
72. 1021*d*. **73.** R5 . 7 . $1\frac{5}{11}$. **74.** 30 times. **75.** 12*s*.

76. £5000. 77. $4\frac{1}{2}$ mi. per hr. 78. $42\frac{1}{3}$.
79. 23 carats fine. 80. $4\frac{1}{2}$ mi. per hr. 81. R$1\frac{31}{312}$.
82. 9 gall. 83. 2 : 1. 84. 12 gall. 85. $5\frac{2}{5}$ gall.
86. 1 : 1. 87. 3145 : 6424 : 1431. 88. 2s. 4d. per stone.
89. R16060. 90. R2. 8a.; 2a. 8p. 91. R78. 2a.; 10a. 2·85p.
92. £7. 15s. $7\frac{661}{1153}$d. 93. 10, 25, 50, 75. 94. 18s.
95. *A* R2400, *B* R900, *C* R240, *D* R60. 96. 28800 ft.
97. 15 rich, 85 poor. 98. 27·815...cu. in. 99. R$3923\frac{1}{13}$.
100. R820, 101. 133. 102. $7\frac{1}{32}$; $4\frac{5}{16}$. 103. £818. 8s.
104. R12960, R11220. 105. £48000. 106. $6\frac{5}{8}$ p. c.
107. 48 mi. 108. £10. 109. $5\frac{1}{4}$. 110. R10538 . 12 . 6.
111. R14508, R12090, R12896, R9672. 112. £$19\frac{5}{7}$.
113. R$4942\frac{6}{41}$. 114. 45 mi. per hr. 115. The steamer; 16 hr.
116. 25. 117. 76. 118. 35 measures. 119. 30 seers.
120. £690. 121. 52. 122. R9180. 123. 1050.
124. 15; $\frac{73}{4000}$ cu. in. 125. £5. 14s. 126. 8400. 127. 144.
128. R5000. 129. 25. 130. $3\frac{5}{9}$ md. 131. $2\frac{2}{9}$ p. c. 132. 2d.
133. R1. 9a. 134. R450. 135. The second is R20 less.
136. 7. 137. 20 da. 138. R7. 8a, R10. 139. R7. 8a., R9.
140. 30. 141. R2. 142. 7 and 1. 143. R3. 12a.
144. By 3d. 145. $56306\frac{1}{4}$; $12577571\frac{353}{1105}$.
146. $1166\frac{2}{3}$, 1169, 1000, 1002. 147. 48 centres, 31 outers.
148. £4. 4s., £3, £1. 16s. 149. R8. 150. R4500.
151. R49. 152. 89. 153. 11. 154. $1\frac{1}{8}$ in.
155. Each man, R2; woman, R2; boy, 12a.; girl, 8a.
156. 7 : 40. 157. 10, 15, 20. 158. 75 p. c. and 25 p. c.
159. $6\frac{3}{8}$ cwt. alloy, $2\frac{1}{2}$ cwt. lead. $\frac{1}{8}$ cwt. tin. 160. 8a., 6a., 4a.
161. 1 md. 162. R2. 163. 6a. 164. 15 hr.
165. $5\frac{5}{13}$ hr. 166. 4 hr. 20 min., 7 hr. 35 min.
167. R46 . 10 . 8. 168. $3\frac{9}{10}$ mi. 169. 4·25 P. M.
170. 18 mi. per hr. 171. $2\frac{1}{2}$ mi. 172. R46. 8a. 173. R37350.
174. 120. 175. $7\frac{41}{181}$ gr. 176. R$5065\frac{7}{8}$ decrease.
177. 140, 168, 160; 840. 178. R15. 179. 20. 180. R400.
181. $15\frac{5}{7}$. 182. £412. 10s. 183. English navvies; £4000.
184. £1050. 185. £34 . 8 . $11\frac{17}{121}$. 186. 1199·365234375 sq. yd.

187. $18\frac{6}{130}$. **188.** $123\frac{1}{3}$. **189.** 2*s*. 8*d*. **190.** $33\frac{1}{3}$. **191.** 12.
192. 48 of each kind. **193.** 90 mi. **194.** 60 p. c. **195.** 31.
196. 21420. **197.** R10022. 4*a*. $6\frac{2}{3}$*p*. **198.** £1239. 13*s*. $4\frac{80}{121}$*d*.
199. £353. 11*s*. $7\frac{7}{27}$*d*. **200.** 3*s*. $7\frac{1}{3}$*d*. **201.** £2000.
202. 11*s*. $7\frac{2}{13}$*d*. **203.** 78 p. c. **204.** £$4654\frac{6}{11}$, £$135\frac{25}{33}$. £$9\frac{23}{33}$.
205. 320. **206.** £3 . 17 . $10\frac{1}{2}$; 5*s*. $1\frac{1}{2}$*d*. **207.** 1100 ft. per sec.
208. $1\frac{1}{2}$ mi. and $\frac{3}{8}$ mi. per hr. **209.** $2\frac{2}{3}$ days after 2nd starts.
210. £13116 . 6 . 8. **211.** 250.
212. 8 min. 4 sec.; 8 min. 15 sec.: 8 min. 26 sec. **213.** 14 min.
214. R$22\frac{2}{9}$. **215.** $9\frac{102}{119}$ min. **216.** R200. **217.** 15 : 9 : 5.
218. 75 sec. **219.** $29\frac{850}{1384}$ mi per hr. **220.** £7 . 11 . 3.

ANSWERS TO CALCUTTA ENTRANCE PAPERS.

1858.

1. $33\frac{1}{3}$. **2.** $\frac{8427}{30000}$. **3.** 1·7320508...; ·5477225... **4.** $1\frac{159}{2401}$ oz.

1859, A.

1. 5 : 22. **2.** 407 yd. **3.** The former; ·2236. **4.** $857\frac{1}{7}$ ac.; $\frac{91}{840}$.
5. £2400. 15*s*. $0\frac{63}{64}$*d*. **6.** 13·427 poles; ·17325. **7.** £1350.

1859, B.

1. 8333 hr. 20 min. **2.** R6. **3.** $1\frac{1}{8}$; ·0079.
4. $10\frac{13}{35}$. **5.** ·00064; ·009 and 400000.

1860.

1. R9963. **2.** 7564; ·7071... **3.** 29; 2. **4.** R6.

1861.

1. 2243·18. **2.** ·035; $\frac{58}{2475}$. **3.** £2142. 5*s*. $4\frac{1}{8}$*d*.
4. $1103\frac{289}{560}$ ac. **5.** ·0316.

1862.

1. ·54. **2.** $\frac{7}{9600}$; 1*s*. 9*d*. **3.** $4\frac{4}{187}$. **4.** In $25\frac{15}{22}$ min. **5.** ·03162...

1863.

1. $11\frac{16}{67}$; 11·2388... **2.** $3\frac{28770}{210700}$. **3.** £143. 7*s*. $11\frac{5}{14}$*d*.
4. $14\frac{27}{28}$ days. **5.** 31·052. **6.** £529. 4*s*. $7\frac{5}{18}$*d*.

1864.

1. 540. 2. 1 ; 2. 3. £77. 14s. $7\frac{5}{18}d$.
4. $4\frac{1}{8}d$. ; ·5885416. 5. ·014 ; ·0001. 6. 6800 : 7221.

1865.

1. $79\frac{253}{625}$; 79·4048 ; ·3415. 2. ·001764 ; 10.
3. $329\frac{1}{10}$ yd. ; R1023. 9a. $7\frac{1}{5}p$. 4. 45 men.
5. R84. 1a. 10p. ; R16. 8a.

1866, A.

1. 2 183125 ; $120\frac{3}{7}$; 13316·875. 2. £96. 16s. $9\frac{1}{3}d$.
3. 39·05 ; 12·348... ; 3d. 4. 12 days. 5. £2. 16s. 0·478447265625d.

1866, B.

1. ·10444637 ; 1. 2. £21. 3s. $6\frac{21}{32}d$.
3. ·00041616 ; 9·042 ; 21·7272... 4. 256 256 ; ·0256256.
5. R210. 6. $99\frac{5}{16}$; £176. 4s. $2\frac{179}{227}d$.

1867.

1. 19 mi. 836 yd. 2 ft. 2. 102050 ; 320·87. 3. Loses £1. 3s. 4d.
4. 1 ; $9\frac{509}{576}d$. 5. $\frac{51}{40000}$, ·001275 ; $\frac{4[illegible]}{2880000}$, ·001699... 6. $9\frac{1}{5}$.

1868.

1. 11s. 3d. ; 5. 2. 12·375... ; 1·816... 3. 440 miles.
4. 401 : 544. 5. £12. 18s. $10\frac{2}{13}d$. 6. $58\frac{3}{4}$ yd.

1869.

1. 4 ; ·023926091 26984. 2. £10. 10s. ; $\frac{1}{48}$.
3. ·02 ; ·0000002 ; ·1414... ; ·004... 4. £14. 7s. $11\frac{5}{8}d$. 5. 16 years.

1870.

1. R15. $11\frac{1}{3}a$. ; 8091 cu. ft. 2. $998999\frac{847}{848}$;
(1) ·001 353 ; (2) 290 ; $2\cdot522\dot{7}$. 3. $140\frac{1}{2}$; 2·0025...
4. $10\frac{5}{7}$ days. 5. Second. 6. $2070\frac{80}{371}$.

1871.

1. R2732. 13a. 2. $\frac{5}{23}$ greatest, $\frac{23}{108}$ least ; £7. 0s. $3\frac{43}{100}d$. ; 1.
3. ·001875 ; 67952·25 ; R68. 3a. $1\frac{1}{2}p$. ; ·154.
4. 55 miles. 5. R3350.

1872.

1. R1597. 10*a*. 3*p*. 2. $\frac{2}{3}$; R15. 2*a*. 4*p*. ; $2\frac{2}{3}$.
3. 5050 ; (i) ·075758 ; (ii) ·677166 ; 30·84.
4. R197. 11*a*. $7\frac{377}{641}$*p*. 5. R262. 8*a*.

1873.

1. (i) $\frac{7}{8}$; (ii) R2569. 7*a*. 7*p*. ; R48. 2. $\cdot\dot{0}03\dot{3}$; $\frac{1}{50}$; ·5048...
3. R20. 11*a*. $2\frac{61}{81}$*p*. 4. 19 yr. 5. 5*a*. $7\frac{1}{3}$*p*. ; R5498. 7*a*.

1874.

1. $\frac{80}{81}$; 1 : 161 ; 3328·226128... ; $\cdot\dot{2}3076\dot{9}$ 2. 63 days.
3. $31\frac{65}{144}$ cu. ft. ; $15\frac{115}{144}$ cu. ft. 4. 120000.
5. R66666. 10*a*. 8*p*. ; R108

1875.

1. 2 ; R50 ; ·2213... 2 $\frac{1}{32}$. 3. R35. 1*a*. 4*p*.
4. R16540. 5. R58. 2*a*. ; $3\frac{34}{55}$.

1876

1. $1\frac{3741}{10724}$; R13. 13*a*. $6\frac{9}{10}$*p*. ; ·4441... 2. 9 ; 23·04484...
3. $12\frac{4}{9}$ yd. ; R1. 12*a*. ; £215. 16*s*. $8\frac{3}{4}$*d*. 4. 200 da. 5. $4\frac{1}{2}$.

1877.

1. $\frac{1}{2}$; £3. 9*s*. 2. R9105. 1*a*. 6*p*. 3. £78. 15*s*.
4. 125. 5. 39 days. 6. R3312 ; R219.

1878.

1. 2062·649... 2. 1·00015... 3. ·375.
4. R24. 14*a*. $6\frac{99}{125}$*p*. 5. $\cdot 0099454\dot{3}6507\dot{9}$. 6. £512. 9*s*. $1\frac{1}{80}$*d*.

1879.

1. 400, 50, 6, $\frac{6}{10}$, $\frac{5}{100}$, $\frac{4}{1000}$. 2. 104. 3. (*a*) 4 ; (*b*) $1\frac{47}{210}$; (*c*) $\cdot 0270\dot{4}\dot{5}$; (*d*) ·001. 4. 18 times. 5. 68 men.
6. Decrease £11. 4*s*. 3*d*. 7. 18.

1880.

1. 100, 20, 3, $\frac{4}{10}$, $\frac{5}{100}$, $\frac{6}{1000}$; $\frac{1}{3}$. 2. (*a*) $\frac{76}{333}$; (*b*) £40 ; (*c*) 2·65.
3. Each boy, £4. 11*s*. ; each woman, £13. 13*s*. ; each man, £27. 6*s*.
4. 65 gallons ; 13 hr. 5. *C* wins by $\frac{880}{8741}$ yd. 6. R25.

1881.

2. $4\frac{67}{140}$; 3. **3.** ·78125 ; R380. 6*a*. **4.** $\frac{41631}{1100}$; 1·8549. **5.** £15400.

1882.

1. 4321. **2.** £5. 18*s*. 9*d*. ; ·57.

3. 30030 sec. ; 15016, 10011, 6007, 2003, 1431, 463, 391 times respectively. **4.** (i) 1600, (ii) 27·96424... **5.** 18 da. **6.** R35000.

1883.

1. $\frac{1}{5}$. **2.** 30 ; ·75. **3.** ·0069$\frac{1}{4}$; R6 ; £10 10*s*. 10*d*.

4. £21. 11*s*. $2\frac{2}{7}$*d*. **5.** R96$\frac{3}{5}$. **6.** 28$\frac{4}{7}$ years ; R562. 8*a*. ; 75 p.c.

1885.

1. $2\frac{3}{5}$; $\frac{17}{650}$. **2.** ·12 ; ·2 ; ·30472... **3.** 3·$\dot{4}6153\dot{8}$; £1. 10*s*.

4. £513. 6*s*. 6$\frac{1}{4}$*d*. ; 3·1225..., ·2828... **5.** 18 ; 8$\frac{1}{2}$ per cent.

6. The first investment is better ; £1342. 10*s*. ; $3\frac{63}{170}$ per cent.

1886.

1. $\frac{875}{972}$. **2.** $\frac{209}{6000}$. **3.** $\frac{153}{761}$; $\frac{279}{800}$. **4.** ·5 ; ·001136.

5. £36. 17*s*. 6*d*. **6.** R28659 6*a*. **7.** R12. 12*a*. 9$\frac{3}{5}$*p*. ; loss R133$\frac{1}{3}$.

1887.

1. (*a*) $\frac{1}{8}$; (*b*) 350. **2.** ·0203125. **3.** (*a*) £17. 12*s*. 2$\frac{1}{4}$*d*. (*b*) R2000. **4.** 10. **5.** R510. **6.** 13·31 ; ·471...

1888.

1. $\frac{8}{14}$. **2.** 11200 ; 37·96. **3.** 138·4497$\dot{1}$; £20. 16*s*. 9$\frac{7}{10}$*d*.

4. £1034. 14*s*. 4$\frac{3}{8}$*d*. **5.** 15$\frac{5}{8}$ days. **6.** 6$\frac{1}{4}$; £100.

1889.

1. 51·59139412. **2.** 8·62126... **3.** £5247. 2*s*. 6$\frac{83}{84}$*d*.

4. 1·000127... **5.** £6705. 14*s*. 7*d*.

1890.

1. 3 ; R23931. 7*a*. 7*p*. **2.** 7305·$\dot{4}0\dot{5}$; $\frac{133}{370}$.

3. R1771. **4.** 60 days. **5.** R104. 4*a*.

1891.

1. (*a*) $\frac{13}{14}$; (*b*) $\frac{1}{4}$. **2.** 2·202642. **3.** R408. 3*a*. 4$\frac{11}{12}$*p*.

4. 9 hr. 41$\frac{7}{14}$ min. **5.** R20800. **6.** 8$\frac{1}{3}$ yd.

1892.

1. $\frac{79}{138}$. 2. 26219. 3. ·312 ; ·098 ; ·998.
4. R1232. 14*a*. $0\frac{24}{73}$. 5. £2500.

1893.

1. (1) $5\frac{67}{140}$; (2) 3. 2. ·0789 ; $\frac{226}{495}$; $\frac{36}{55}$; $1\cdot\dot{1}$. 3. £345. 7*s*. $3\frac{3}{4}$*d*.
4. R238. 3*a*. $2\frac{138}{161}$*p*.
5. R90,000 in the 4 per cent. stock and 73000 in the 5 per cent. Municipal debenture stock.

1894.

1. £37. 0*s*. $8\frac{1}{4}$*d*. 2. £491. 8*s*. 3. 16*s*. 0·375013*d*.
4. ·9998. 5. 6 Rupees per head.

1895.

1. 1·00001. 2. R12345. 3. 3 francs 84 centimes. 4. 1.
5. Increase of R47 ; ·6832876712.

1896.

1. Greatest number = 23704543, and least number = 8143.
2. (1) $\frac{5}{12}$; (2) ·075088. 3. 2·2677.... 4. R531. 3*a*. $10\frac{8}{121}$*p*.
5. $1\frac{3}{8}$ per. cent. loss. 6. R21735.

1897.

1. ·0725. (*a*) $\frac{3}{13}$. 2. Yes, 320th part ; R32. 9*a*. $1\frac{1}{3}$*p*.
3. 20. 4. $33\frac{1}{3}$ yr. 5. R6 per share. 6. 1·7724...

ANSWERS TO MADRAS ENTRANCE PAPER.

1857.

1. $\frac{5}{7}$. 2. ·019. 3. R381.
4. 1371. 5. 4 ft. 2 in. 6. £39. 7*s*. 6*d*.

1858.

1. R49. 11*a*. $11\frac{7}{8}$*p*. 2. 342250 lb. ; 47 hr. 32 min. 5 sec.
3. ·23007...of a mile. 4. 57°. 17′ 45″ nearly.
5. R774. 0*a*. $6\frac{18}{61}$*p*. 6. Gain R$25\frac{205}{853}$.

1859.

2. Receipts per week per mile in 1858 were R6. 1*a*. $4\frac{241}{432}$*p*. more.
4. ·006, $6\cdot\dot{6}$; ·620. 5. 3 ac. 3 ro. 16 po. 18 yd. 7 ft.
6. 11969 sq. yd. 4 ft. 20·41 in. 7. 79·8 ; 81·1, 74·6, 82·1...

1860.

1. 56831327. 2. 26292. 3. $\cdot 2\dot{0}04\dot{5}$.
4. $\frac{511}{8100}$. 5. 34·004. 6. R1087. 8a. $11\frac{3}{7}p$.

1861.

1. A, R22840 ; B, R11420 ; C, R3806. 10a. 8p. ; D, R7613. 5a. 4p.
2. $1\frac{25}{36}$. 3. $\frac{110}{1431}$; 343. 4. R68. 2a. 5·825536p.
5. R6714. 12a. $11\frac{25}{31}p$. 6. 1091495·428571.
7. ·065. 8. $26\frac{3}{19}$ per cent. 9. R202. 2a. $0\frac{24}{65}p$.

1862.

3. $\frac{17}{105}$. 4. 17. 5. £478. 18s. $8\frac{95}{128}d$.
6. $\cdot\dot{5}7142\dot{8}$. 7. 8·039. 8. 9 days. 9. 45 miles per hour.

1863.

1. 1962, rem. 123. 2. (1) £206. 12s. $5\frac{1}{2}d$. ; (2) R2066. 3a. 8p.
3. (1) $\frac{130}{241}$; (2) $8\frac{29}{30}$; (3) R3. 14a. 4. 4·4137 ; $411\cdot\dot{1}$.
5. £56. 2s. 6d. 6. 357 ; 3·57 ; 1·414...
8. R716. 10a. 8p. ; R358. 5a. 4p. 9. The steamer ; 16 hours.

1864.

1. 9 hr. $37\frac{8}{11}$ min. 2. $\frac{113}{156}$ greater by $\frac{1}{7810}$. 3. 696 lb. 9·6 oz.
4. $1\frac{133}{135}$. 5. R14. 9a. 4p. 6. $4\frac{1}{7}$; ·123.
7. £115. 18s. 9d. 8. $3\cdot 2743\dot{6}$. 9. ·25 miles.

1865, A.

1. £22. 4s. $10\frac{1}{8}d$. 2. R120. 3. (1) 10 ; (2) 20. 4. 11 ft. $6\frac{1}{8}$ in.
5. 2·3804... ; ·0670... 6. $12\frac{1}{3}$. 7. $\cdot 208\dot{3}$. 8. £5888.

1865, B.

1. R16666. 10a. 8p. 2. 7 da. 10 hr. 25 min. 30 sec.
3. R241. 0a. 3p. 4. $\frac{8}{81}$. 5. 20. 6. (a) $\frac{113}{168}$;
(b) 10a. 6p. 7. (a) 7·31 ; (b) $\frac{13}{30}$ or $\cdot 4\dot{3}$. 8. 8 hours.

1866.

1. 226875 lb. 2. R32. 7a. 3. $\frac{189}{1000}$; ·189. 4. 57 men.
5. $\frac{3}{11}$. 6. 14·003... 7. 25 per cent. 8. $\frac{3}{8}$.
9. 1st child R5184, 2nd R2592, 3rd R1728.

1867.

1. 240 men. **2.** 193 ft. 4 in. **3.** 5. **4.** $\dot{0}909\dot{1}$.
5. R3. **6.** 32 days. **7.** 60 stones. **8.** 25 ch.

1868.

1. $1\frac{5}{108}$. **2.** £2428. 15*s.* ; £1238. 13*s.* 3*d.* ; £1190. 1*s.* 9*d.*
3. £900. **4.** 1562 ft. **5.** ·$16\frac{64}{121}$ ft. **6.** 6 hr. 59 min. 15 sec.
7. R9. 7*a.* 3*p.* **8.** $8\frac{3}{4}$. **9.** 3*a.* $6\frac{6}{23}$*p.*

1869.

1. The second is greater by ·0708$\dot{3}$. **2.** $\frac{1}{141250}$; 793·7454...
3. 220 yd. by 165 yd. Area = $7\frac{1}{2}$ ac.
4. Legacy, R15000 ; each charity, R4500. **5.** R2790. 10*a.* ; $\frac{894}{1132}$.
6. *A* receives 6*s.* 8·0325*d.* more than *B.* **7.** 12 lacs ; R5.
8. $36\frac{2}{3}$ miles ; 37 minutes past 8 A. M. **9.** 266·$\dot{6}$. **10.** $16\frac{2}{3}$ da.

1871.

1. R5. **2.** (*a*) 1 ; (*b*) $\frac{1}{3}$. **3.** £419. 19*s.* 3*d.*
4. 6*p.* **5.** £233. 17*s.* 10*d.* ; $5\frac{1}{8}$*d.* **6.** 2 years.
7. 12*s.* **8.** 4 sq. in. **9.** 70 oz. **10.** 22 miles.

1872.

1. 8 gall. **2.** (*a*) $\frac{1}{4}$; (*b*) ·2 **3.** R2080. 8*a.*
4. ·03$\dot{3}$22751 ; (*a*) ·014 ; $2\frac{1}{22}$. **5.** $8\frac{1}{3}$ p. c. **6.** R76800.
7. 12*a.* in the R. **8.** 1000 oz. **9.** R20. 5*a.* **10.** 121 yd. ; $6\frac{7}{8}$ sec.

1873.

1. 76 ac. **2.** 1 ; ·25. **3.** £1000 ; £4000.
4. ·35 measures. **5.** 18 miles. **6.** R770 ; 1 p. c.
7. £1000 ; 2 and $2\frac{1}{2}$ years. **8.** R13680.
9. 8 yd. ; 3 hr. **10.** Faster 99 yd. ; slower 77 yd.

1874.

1. 39 ; 319. **2.** 17*s.* 6*d.* **3.** (*a*) $\frac{5}{7}$; (*b*) ·125.
4. 9*s.* 7*d.* ; ·01. **5.** 30 seers. **6.** £250 ; 4 per cent.
7. £690. **8.** $277\frac{1}{3}$ cu. in. **9.** 2 : 1. **10.** $2\frac{1}{2}$ miles.

1875.

1. R441. 7*a*. 2. 1·61 ; 11344$\frac{3}{8}$. 3. ·02291$\dot{6}$.
4. 10$\frac{1}{6}$ days ; 4$\frac{70}{81}$ cu. ft. 5. R46. 8*a*. 6. $3^2.5.7^2.11^2.13^3.$; 5.
7. 15 ft. 8. £1600. 9 67 yd. ; 125. 10. 9 p. c.

1876.

1. 550 yd. 2. R8, R16, R24. 3. R19. 15*a*. 4. 10 days.
5. R180. 6. R122415 . 7 . 3$\frac{1}{3}$. 7. 17·75 ft. ; 25·10 ft.
8. £65. 9. R421 ; 10 p. c. 10. R33750.

1877.

1. R603. 13*a*. 9*p*. 2. 13$\frac{1}{3}$ days. 3. .017 ; 35·0622...
4. R17. 1*a*. 8*p*. 5. 13 per cent. 6. R103. 1*a*. 3*p*.
7. £49 16*s*. 8. R4200 9. 4$\frac{1}{6}$ measures.

1878.

1. (*a*) R1239. 13*a*. 1*p*. ; (*b*) R51738. 3*a*. 3*p*. 2. 52 days.
3. (*a*) ·00032 ; 3·2 ; (*b*) 8. 4. R9180. 5. R1$\frac{67}{125}$.
6. R276. 5*a*. 3*p*. ; 31440. 7. 27 days.
8. ·0047... ; 27·6568... 9. 25 shares.

1879.

1. R606. 11*a*. 3$\frac{1}{2}$*p*. 2. 10 days. 3. R825 ; 8 p.c.
4. R13. 2*a*. 10$\frac{2}{3}$*p*. 5. 2·0918... ; ·5773.. 6. R68. 13*a*. 4*p*.
7. £1780. 19*s*. 8$\frac{4}{61}$*d*. 8. R111111$\frac{49}{441}$. 9. 3 hr. 40 min.

1880.

1. 6$\frac{2}{3}$ ft. 2. 3 miles. 3. ·$\dot{5}9\dot{2}$. 4. 3 annas.
5. Width, 18$\frac{1}{2}$ ft. ; height, 14$\frac{1}{2}$ ft. 6. 2469 ; ·0788...
7. 7$\frac{1}{2}$ hours. 8. 3$\frac{1}{2}$ per cent.
9. Each child, R960 ; each brother, R495.

1881.

1. R241. 8*a*. 8*p*. ; R5267, 11*a*. 7$\frac{1}{2}$*p*. 2. R666. 12*a*.
3. R37350. 4. 48$\frac{1}{16}$; ·2070... 5. $\frac{2}{15}$; $\frac{2}{1000}$; [illegible] ; [illegible].
6. 14 years. 7. R10022. 4*a*. 6$\frac{2}{3}$*p*. 8. R28500.
9. Slower 15$\frac{5}{21}$ miles ; faster 29$\frac{1}{2}$ miles.

1882.

1. ·387. **2.** 9. **3.** 13 ft. 4 in.
4. 294·151. **5.** (*a*) 210 ; (*b*) 179.
6. (*a*) Percentage obtained by *A* is 52, *B* 69, *C* 64·2, *D* 57·2, *E* 68·7 and *F* 40·2 ; (*b*) 64·3 in Arithmetic, 55·4 in Algebra, 46·2 in Euclid, 67·1 in English, 65·2 in History, 62 in Geography, 41·9 in Handwriting ; (*c*) 60 per cent.
7. ·428571. **8.** R1711. 12*a*. **9.** 675 lb.

1883.

1. 27 gallons. **2.** 4*d*. **3.** 27 days. **4.** 4 hr.
5. £1345. 16*s*. 8*d*. ; £107. 13*s*. 4*d*. ; R8 per cent.
6. *A*, 4 hr. 20 min. ; *B*, 7 hr. 35 min. **7.** £190.
8. 0. **9.** 1000 yd.

1884.

1. 1. **2.** R1455. 4*a*. 4*p*. **3.** 1·00904... ; 107·916.
4. R962. 3*a*. 5*p*. **5.** The side of the cube is 7 in. ; 7776.
6. *A* R480, *B* R533. 5*a*. 4*p*., *C* R466. 10*a*. 8*p*. ; $1\frac{1}{3}$ per cent.
7. R3125. **8.** £8. **9.** $4\frac{1}{6}$ per cent. **10.** R211. 9*a*.

1885.

1. $\frac{1}{3}$. **2.** $\frac{95}{192}$, 64 Rupees. **3.** £1. 6*s*. $0\frac{1}{2}$*d*. **4.** £19. 3*s*. $10\frac{7}{8}$*d*.
5. 11*s*. $10\frac{1}{2}$*d*. **6.** R1920. **7.** 3*s*. 9*d*. **8.** 4 years.
9. £5000. **10.** ·9196 ; £4. 2*s*. 6*d*. **11.** 350000 men.

1886.

1. 1. **2.** ·9705. **3.** £2. 11*s*. $5\frac{3}{4}$*d*. **4.** R3955. 3*a*. 11*p*.
5. 1-13 p. m. 2nd July. **6.** 60 men. **7.** £1000. **8.** £180.
9. R17. 8*a*. **10.** 520344000 cub.-ft. ; $1\frac{47}{88}$ in.

1888.

1. (1) £116566. 8*s*. $7\frac{1}{2}$*d*. (2) R142076. 4*a*. 9*p*. **2.** $\frac{3}{4}$.
3. 1*a*. 4*p*. ; ·$11458\frac{1}{3}$. **4.** £721. 15*s*. $6\frac{9}{16}$*d*. **5.** £335000.
6. £416. 13*s*. 4*d*. **7.** R7. 2*a*. **8.** Increase of R502. 8*a*.
9. R500000. **10.** 500400.

1889.

1. £14004. 12s. 4½d., R103992. 12a. 7p. 2. $\frac{7}{8}$.
3. ·082730̇29̇ ; 6s. 9¾d. 4. R1730. 13a. 6¼p. 5. R48. 2a.
6. £1694. 13s. 9d. 7. R280000. 8. 10 days.
9. 7500274. 10 £39. 3s. 9d. 11. 2·08008.

1890.

1. 342 ac. 2 ro. 39 po. 2 sq. ft. 36 sq. in. ; 160 yd. 2. 1·5.
3. R975358. 9a. 2½d. 4. 30 weeks. 5. R·744273.
6. 4 months. 7. Increase of £397.
8. 12 cwt. 1 qr. 19 lb. 4 oz. ; £33. 2s. 6d.
9. 343 : 169. 10 19487·171.

1891.

1. £42900. 2. R1. 11a. 8p. 3. R1. 10a. $2\frac{11}{181}$p.
4. 9 ; 46·94718. 5. 12'. 6. R6. 6a. 4p. ; R158.
7. £291. 9s. 5¼d. nearly. 8. 20' afternoon. 9. 10d. 10. R9180.

1892.

1. 311993 tons. 10 cwt. 12 lb. ; 219505 kandis 7 md. 1 vis. 7 palams. 2. ¾. 3. 5s. 3d. ; ·0037115625.
4. R67567. 9a. $7\frac{1}{3}$p. 5. £416. 13s. 4d. 6. 3·700965.
7. 3221625 tons. 8. R355. 13a. 4p. 9. R55. 8a. 4p.
10. $3\frac{1}{8}$ per cent. 11. 25640000.

1894.

1. R2130333. 11a. 9p. ; 755 mi. 4 fur. 2 po. 4 yd. 2. ½.
3. 5s. $2\frac{13477}{18000}$d. 4. R1593. 4a. $5\frac{8}{9}$p. 5. R93333. 5a. 4p.
6. £976. 11s. 3d. 7. R23. 12a. 4p. 8. 4½ miles.
9. R1062. 10. 14·1625 per cent. 11. 9·0073210.

ANSWERS TO BOMBAY ENTRANCE PAPERS.

1859.

1. R42. 2. R58. 7a. 9p. 3. $8\frac{1}{6}$. 4. $1\frac{1}{11}$. 5. $2\frac{1}{12}$.
6. 4200. 7. 108 da. 8. ·0097̇2̇. 9. 1·581... ; ·25 ; 1010101.

10. 15·4041 feet. 11. R12550. 14*a*. 1·152*p*.
12. Each man, R83$\frac{1}{3}$; each woman, R55$\frac{5}{9}$; each child, R27$\frac{7}{9}$.

1860.

1. 622$\frac{2}{9}$ac. 2. 21 ; $\frac{2}{3}$. 4. 11·8125 ; ·559375
5. ·000018 ; 1800000 ; ·01536. 6. £720.
7. Income increases by R500. 8. R1852. 14*a*. 10$\frac{1}{2}$*p*.
9. R4169. 9*a*. 10$\frac{2}{3}$*p*., 29$\frac{1}{4}$ years.
10. 3 tons 4 cwt. 3 qr. 4 lb. 13 oz. 11. 7·6 feet.

1861.

2. R50648. 1*a*. ; 2$\frac{277}{393}$. 3. R1. 7*a*. 7$\frac{811}{2187}$*p*. 4. R233. 15*a*. 10*p*.
5. $\frac{13}{27}$; R4. 6*a*. 4$\frac{6}{14}$*p*. 6. (1) ·34765625 ; (2) ·00084765625 ; (3) 84765·625 ; 1250 ; ·0125 ; ·0000000125.
8. R11111$\frac{1}{9}$ 9. Simple Interest £50 ; Comp. Int. £51.

1862.

1. $3x^6+4x^5+5x^4+2x^3+x^2+6x+7$. 2. 248·2... ; ·004028...
3. 33$\frac{5918197}{7110700}$ years. 4. 240 rupees ; 360 two-anna pieces ; 960 pysas. 5. 2$\frac{8}{33}$. 6. ·$\dot{2}\dot{6}$. 7. ·0891 ; ·2986...
8. R2164. 6*a*. 2$\frac{1}{2}$*p*. 9. ·579... 10. R93$\frac{1}{4}$; R86$\frac{2}{3}$.
11. R1. 3*a*. per 100. 12. 8·2265625 metres.

1863.

1. 7369. 2. R45. 3*a*. 4*p*. 3. 2*s*. 4*d*. 4. *A*, *B*, *C*, R615 ; *D*, R410.
5. 91 da. 21 hr. 14 min. 15 sec. 6. ·0246 ; ·940625. 7. 215·484...
8. R333. 5*a*. 4*p*. 9. £11. 11*s*. 5$\frac{49}{108}$*d*. 10. R18.

1864.

2. 3 ; common measure 3. 3. 565656 7742. 4. 1$\frac{315}{1112}$.
5. 4261·7415 ; 3888·8985 ; 759727·26738 ; 21·86...
6. Saltpetre 840 lb., sulphur 112 lb. and charcoal 168 lb.
7. 10·737... 8. *A*'s R3451$\frac{17}{23}$, *B*'s R2876$\frac{2}{3}$ and *C*'s R10462$\frac{8}{23}$.
9. R16043. 13*a*. 4$\frac{22}{37}$*p*. 10. 1584 lb.

1865.

2. R40457. 11*a*. 9*p*. 3. R52. 4. 405756 ; R12065. 12*a*.
5. 5$\frac{4}{15}$. 6. ·0$\dot{3}$; ·$\dot{0}$32258064516129$\dot{}$; ·03125.

7. Increase by R3. 7*a*. $4\frac{10}{101}p$.
8. *A* R$22222\frac{2}{9}$; *B* R$33333\frac{1}{3}$; *C* R$44444\frac{4}{9}$; *D* R$46153\frac{11}{13}$;
E R$30769\frac{3}{13}$; *F* R$23076\frac{12}{13}$.
9. 12 shares ; R1460. 10. 53 hr. 11. 416·4 ; 12·3.

1866.

2. $1\frac{8}{9}$; (*a*) $\frac{11}{18}$. 3. R2000 ; R5000. 5. $\cdot 149553\dot{5}7142\dot{8}$.
6. (i) 44·153157 ; (ii) 11·569328 ; (iii) $\cdot\dot{4}9950\dot{0}1$; (iv) 50000 ; (v) 46·04.
7. R$1636363\frac{7}{11}$; increase of income R10000.
8. £515. 16*s*. $7\frac{1}{2}d$. 9. 14*a*. 3*p*. 10. $6\frac{7}{17}$ months.

1867.

2. 2, 2, 5, 3, 3, 7, 43. 3. $14\frac{31}{35}$. 4. $\cdot\dot{8}5714\dot{2}$; $1\frac{3473}{4950}$.
5. 788·423. 6. $4\frac{4}{9}a$. R$\frac{5}{18}$. 8. 90 men. 9. 3 yr. 8 mo. 24 da.
10. 110 ; 90 ; 30 ; 10. 11. 78·0064... ; ·0158... ; ·3902...
12. R41. 10*a*. 8*p*. ; 8 cwt. 1 qr. $20\frac{4}{9}$ lb.

1868.

1. $52\frac{1}{2}$ yd. 2. R14557. 1*a*. $0\frac{4}{5}p$. 3. $\frac{1}{4940}$.
4. $\frac{7}{990}p$. 5. £$25\frac{224559}{1400250}$. 6. $45\cdot\dot{6}9230\dot{7}$.
7. R$76363\cdot\dot{6}\dot{3}$. 8. $1\frac{89}{90}$ per cent. 9. 465.
10. 9*s*. $4\frac{838}{1253}d$. 11. 23 men. 12. £30. 4*s*. $8\frac{1}{4}d$.

1869.

1. 97 ; 1008. 2. 1. 3. 2. 4. $\frac{1}{64}$, $\frac{1}{84}$. 5. $\cdot 648958\dot{3}$.
6. R393 13*a*. ; R656. 5*a*. 8*p*. ; R1050. 2*a*. 8*p*. ; R1181. 7*a*.
7. 4 per cent. 8. £1340. 1*s*. 10·95375*d*. 9. 9 days.
10. Increase R428. 11. 1769 ; $20\cdot 8\dot{3}$.

1870.

$11\frac{513}{625}$ · 11·8208. 3. $\frac{5}{84}$; $\frac{125}{182}$ 4. £81. 5. R25600.
6. 401 . 544. 7. 5 dwt. $3\frac{171}{623}$ gr. ; 3 dwt. $15\frac{3}{11}$ gr.
8. £35. 16*s*. $10\frac{1}{3}d$. 9. R900 ; R600 ; R2100.
10. ·314642... 1·816590... 11. £$585\frac{5}{47}$.

1871.

1. 192000 mi. 2. 1287 ; 9009. 3. $\frac{7}{1800}$. 4. $\frac{1}{32}$; $\frac{27}{37}$; R5. 11*a*.
5. £606. 6. $4\frac{16}{21}$. 7. $9\frac{13}{32}$; R2956. 4*a*.
8. 83149. 9. $5\frac{170}{899}$ decrease. 10. 1055 subscribers.

1873.

1. $\frac{1}{230}$. **2.** 13*s.* 10½*d.* ; $\frac{37}{84}$. **3.** $\frac{9}{80}$. **4.** R1500. **5.** $7\frac{1}{7}$ hours.
6. £2376. 5*s.* **7.** 30780 **8.** 76. **9.** 55½. **10.** 1234.

1874.

1. 1. **2.** 48. **3.** $\frac{6}{37}$. **4.** £213. 12*s.*
5. R14586. **6.** 13*s.* 4*d.* **7.** R26.
8. $7\frac{1}{23}$ per cent. ; R1840 interest yearly ; $4\frac{5}{16}$ per cent.
9. 36 miles and 24 miles per hour.
10. They are in order of magnitude.

1875.

2. 21 mi. 6 fur. 33 po. 3 yd. 2 ft. 7 in. **4.** 528093440.
5. $1\frac{73}{152}$. **6.** $\frac{1}{2}$: $\frac{6}{13}$; $\frac{13}{93}$. **7.** 10·017.
8. $6792\frac{21}{35}$. **9.** 27·3 ; 32. **10.** $3\frac{6}{25}$*s.* ; $4\frac{8}{25}$*s.* ; $5\frac{19}{25}$*s.* ; $7\frac{17}{25}$*s.*
11. R18750 ; R56. 4*a.* increase. **12.** $3\frac{137}{288}$ sq. ft.

1877.

2. *B* is $\frac{1}{24}$ of a mile in advance of *A*. **3.** $\frac{1}{16}$.
4. Tea R2. 8*a.*, sugar 2*a.* 8*p.* **5.** 217½ ft. ; 242 times.
6. *A* R850, *B* R846 and *C* R1182. **7.** £650.
8. £818. 8*s.* **9.** ·0061. **10.** $9\frac{93}{220}$ miles.

1878.

1. £90. 18*s.* 11¾*d.* **2.** 1. **3.** £4. 0*s.* 9*d.* **4.** 83 ft. 5 in.
5. 25 per cent. **6.** R7678. 2*a.* ; 10*a.* 2·85*p.* **7.** £1500.
8. £215. 8*s.* $9\frac{15}{21}$*d.* **9.** £20. **10.** £2890. 10*s.*

1879-80.

1. 48023601 ; 45942521. **3.** £5. 0*s.* 0¾*d.* **4.** 1 ; $\frac{11}{15}$.
5. R10. **6.** $3\frac{1453}{11804}$ per cent.

1880-81.

1. $2\frac{5}{17}$; 4½ ; $6\frac{23}{34}$. **2.** $30\frac{15}{22}$ sec. **3.** 26 coolies.
4. 2 years. **5.** £273. 8*s.* 9*d.*

1881-82.

1. £1508. 15*s*. $7\frac{119}{160}$*d*. 2. 1 minute. 3. 10*s*. $10\frac{2}{3}$*d*.
4. R2646. 5. 4 per cent. 6. $\cdot 8\dot{3}$; 75·1.

1882-83.

1. 11*s*. 11·25*d*. ; ·03671875. 2. 24 posts.
3. $9\frac{3}{4}$ weeks ; £341. 5*s*. 4. £4328. 2*s*. 6*d*. 5. 77 yd. 2 ft. 11 in.

1883-84.

1. (*a*) 16,000,075,040,002 ; (*b*) 1 ; (*c*) £24. 19*s*. $5\frac{1}{2}$*d*.
2. 360 ; 2nd, 72 ; 3rd, 60 ; 4th, 45 ; 5th, 40 ; 6th, 36.
3. 22 yd. 4. £86. 11*s*. 5. 13312 ; 93·05 ; 9·1.

1884-85.

1. $\frac{3}{7}$; ·725 ; £1. 13*s*. $9\frac{3}{80}$*d*. 2. £2. 9*s*. $0\frac{24}{77}$*d*.
3. £15. 16*s*. 2*d*. 4. £7 increase. 5. 4 per cent.

1885-86.

1. $\cdot 4\dot{8}5714\dot{2}$ 2. 113 boys. 3. $5\frac{1}{3}$ qr., £$1\frac{3}{40}$. 4. £72. 6*s*. 8*d*.
5. The latter investment more profitable; £$457\frac{103}{400}$.

1886-87.

1. $5 \times 7 \times 11 \times 13$, 22·9999891208453... 2. $192\frac{1}{2}$ ft. 3. $\frac{1}{5}$.
4. (i) 7 ft. 2 inches, (ii) 3·5752. 5. £5103. 6. $3\frac{179}{187}$ per cent.

1887-88.

1. 6. 2. 19*s*. 3*d* 3. 20 months.
4. 20 ; 7 ; 5*s*. $1\frac{1}{2}$*d*. 5. 5*a*. 4*p*.

1889-90.

1. 2. 2. $5\frac{3}{8}$ ft. long by $5\frac{3}{5}$ ft. broad by $5\frac{5}{7}$ ft. deep.
3. 5-15 o'clock. 4. R32000. 5. 3 parts of the one to 13 parts of the other.

1891-92.

1. (i) $\frac{1}{8}$, (ii) $\cdot 8\dot{3}$. 2. Weight allowed is 100 lb. ; they had 2 cwt. and 3 cwt. 3. They last agreed at 10 hr. 30 min. P. M. when they both indicated 10 hr. 30′. 50″. 4. R640.

1892-93.

1. ·00502083̇ ; 15 annas $7\frac{11}{25}$ pie ; $\frac{1}{7}$.
2. 10 days.
3. 3 hr. 30 min.
4. £259. 3s. $5\frac{1}{4}d$.
5. 401 : 544.

1893-94.

(Set in the Mofussil.)

1. 20577 ; 39690 ; ·5184429327286470143613oo07...
2. £11. 11s. $6\frac{3}{4}d$.
3. 2 cwt. 2 qr. 20 lb.
4. £83. 6s. 8d.
5. $12\frac{1}{2}$ hr.
6. 4 lb. of the inferior to 5 lb. of the superior quality.

1893-94.

(Set at Bombay.)

1. (i) 24 ; (ii) $1\frac{8}{16}$.
2. £32. 14s. $3\frac{3}{7}d$.
3. $3\frac{9}{13}$ months.
4. £3. $2\frac{2}{29}$s.
5. $\frac{13}{24}$ths.
6. At the same time on the afternoon of the 23rd August when the first clock will show 1-46′ and the second 2-16′.

1894-95.

1. 146097 days.
2. 156.
3. 30.
4. $1\frac{1}{3}$ days.
5. R2160.
6. 7·72 ; $15\frac{1}{4}$ annas.

ANSWERS TO PUNJAB ENTRANCE PAPERS.

1875.

1. 1,001,001 ; 766.
3. (1) $6\frac{1}{2}$; (2) $\frac{213}{280}$.
4. 1 ro. 14 sq. po. ; ·72̇
5. 999 ; 1·772...
6. 15.

1876.

1. 2881·161... revolutions.
2. R3281. 1a. 6p.
3. R800. 1a. 9p.
4. $22\frac{2}{7}$ seers for a rupee.
5. R3992. 11a. $8\frac{1013}{1825}$p.
6. 220 days.

1877.

1. 1s. 11·67d.
2. (a) 18 min. ; (b) $11\frac{513}{628}$; 11·8208.
3. 34·3168 ; 5·858...
4. (a) R$4838\frac{22}{31}$; (b) $531\frac{13}{47}$; R$31\frac{43}{47}$.

1878.

1. R5. 10*a*. 2*p*. **2.** $1\frac{5}{13}$; $\cdot\dot{1}9780\dot{2}$. **3.** $\cdot 00\dot{0}\dot{3}$; $\cdot 00296...$
4. 338 sq. ft. **5.** 5 per cent. per annum. **6.** ·316... ; ·0001

1879.

1. (*b*) $\frac{5}{9}$ and $\frac{13}{48}$; $\cdot 2847\dot{2}$ **2.** $\frac{11}{17}$. **3.** 2·115...cu. in.
4. (*a*) $\frac{184}{3105}$; (*b*) $\cdot 031\dot{6}$. **5.** 316·227... yd.

1881.

2. 9·45 ; 2·2371... **3.** ·03168... **4.** R14. 13*a*. $8\frac{4}{23}p$.

1883.

1. ·6848 **2.** 12. **3.** (*b*) $\frac{211}{495}$.
4. $3\frac{3}{4}$ hours. **5.** 140 ; 170 ; 190. **6.** R507. 8*a*. decrease.

1884.

2. ·02688, ·002688 ; 25·6, 2·56 **3.** 1. **4.** 1·0001.
5. R62. 10*a*. $5\frac{13}{40}p$. **6.** 8*a*. $11\frac{2927}{4165}p$. **7.** The former greater.

1885.

1. 1 ; 123 times. **2.** ·08125 ; $\cdot 00\dot{0}\dot{3}$; $\cdot\dot{0}3896\dot{1}$.
3. R884. 15*a*. 3*p*. **4.** £9. 15*s*.
5. 7056 ; 2420 sq. yd. **6.** The latter ; R49000.

1886.

1. ·375 ; ·612... **2.** ·7895. **3.** $\frac{1}{40}$. **4.** She loses.
5. R195. 13*a* 0·96*p*. ; R172. 8*a*. $5\frac{17}{127}p$.

1887.

1. (*c*) 3·025. **2.** £133. 6*s*. 8*d*. **3.** R9. 6*a*. $8\frac{1}{4}\frac{5}{7}p$. per maund.
4. R316$\frac{57}{575}$; R266$\frac{203}{283}$; R221$\frac{87}{283}$; R195$\frac{15}{23}$.
5. R11029. 6*a*. $7\frac{1}{17}p$. **6.** 1·321...

1888.

1. 1[illegible] **2.** [illegible] **3.** 16 days. **4.** 17 per cent. **5.** 32·867.

1889.

1. $\cdot 32208\dot{3}$; 799. **2.** $2\frac{3}{4}$ miles. **3.** $3\cdot 7\dot{6}5\dot{1}$; 2 min. 6 sec.
4. R14. 8*a*. $6\frac{6}{7}$*p*. **5.** $\sqrt[3]{3}$ greater ; the latter.

1890.

1. (*a*) 1 ; (*b*) ·015789... **2.** $\frac{5}{75}$; $\frac{25}{64}$. **3.** £1324. 13*s*. $9\frac{15}{17}$*p*.
4. 8320 men. **5.** R$86\frac{21}{31}$. **6.** 2*p*.

1891.

1. (1) $1\frac{1}{21}$ (2) 11. **2.** ·0064453125. **3.** 10 years.
4. £200 ; 5 years. **5.** 45 gallons.

1892.

1. $\frac{1}{791}$: the latter comes nearest. **2.** 5·90625.
3. 218972·16 gallons. **4.** £$10166\frac{2}{3}$; £6000. **5.** 17*s*. 3*d*. per gal.

1893.

1. R1000600. **2.** 13·713729902. **3.** ·41421.
4. R17. 5*a*. $9\frac{1}{4}$*p*. **5.** 32 miles.

1894.

1. $\cdot\dot{5}7142\dot{8}$; $\cdot\dot{4}2857\dot{1}$. **2.** Length ·44 ft., breadth 33 ft.
3. £511. **4.** Present value by common calculation *i.e.*, by deducting interest is R987. 8*a*. ; present value by deducting discount is R987. 10*a*. $5\frac{13}{27}$*p*.

1895.

1. $1\cdot 0\dot{7}1428\dot{5}$. **2.** 1·25 lb. **3.** £391, £529, £1311.
4. 2·2360679. **5.** Length 76·2 yd., breadth 38·1 yd.

ANSWERS TO ALLAHABAD ENTRANCE PAPERS.

1889.

1. $1\frac{5}{13}$; $1\cdot\dot{3}8461\dot{5}$. **2.** (*a*) $3\frac{9}{11}$; (*b*) $\cdot 000\dot{3}$; ·00296...
3. ·0316... ; ·91. **4.** R1300. **5.** 12 min. $40\frac{10}{11}$ sec.
6. 8 days. **7.** $39\frac{3}{4}$ miles from their starting place.

1890.

1. ·696294007 ; 36·55086... **2.** $\frac{1}{21}$. **3.** R8600. 13*a*. $10\frac{1}{3}p$.
4. ·99999... **5.** 2·115...cu. in. **6.** $11\frac{9}{41}$ in.

1891.

2. $115\frac{3689410803}{4417873500}$. **3.** $\frac{111}{234}$. **4.** 5 per cent. **5.** 9999 : $7\frac{1}{4}$.

1892.

2. (*a*) 12 ; (*b*) $\frac{109}{96}$, $\frac{5}{27}$, ·84375. **3.** $56\frac{2}{3}$ days. **4.** £3.
5. 1·0001...

1893.

2. 2 fur. $12\frac{2}{11}$ po. **3.** R3. $7\frac{11}{28}a$. **4.** £14. 1*s*. $3\frac{5}{8}d$.
5. £350. 11*s*. 8*d*. **6.** 1869.

1894.

1. (*a*) 999 × 807 = 806193. (*b*) − 1. **2.** (*a*) ·000$\dot{9}$. (*b*) 5·059.
3. 444 miles. **4.** R555.

1895.

1. (*b*) 4 feet square. **2.** (*a*) $\frac{511}{8160}$; (*b*) 1·7724... **3.** R5700.
4. R7 . 6 . $11\frac{1}{7}$ and R4 . 15 . $3\frac{3}{7}$. **5.** 150 yards.

1896.

1. (*a*) $1\frac{3}{10}$; (*b*) 25. **2.** (*a*) ·0203125 ; (*b*) 200·001.
3. 178 hr. 52 min. 30 sec. **4.** $7\frac{1}{2}$ miles. **5.** R2800.

1897.

1. 47 ; 127041. **2.** ·28$\frac{3}{4}$. **4.** £315. **5.** 2203·90625 francs.

APPENDIX.

A. To prove that the multiplier and multiplicand may be interchanged without altering the value of the product.

For example, to prove that $5 \times 4 = 4 \times 5$.

Place 5 dots in a line, and repeat this line 4 times. The number of dots in a row is 5, and there are 4 rows; therefore the number of dots altogether is 5 multiplied by 4. Again the number of dots in a column is 4, and there are 5 columns; therefore the number of dots altogether is 4 multiplied by 5. Hence $5 \times 4 = 4 \times 5$

$$\begin{array}{ccccc} \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot \end{array}$$

B. The product of a recurring decimal by a whole number or by a terminating decimal may be obtained without converting them into vulgar fractions. It is evident that the product in such a case will be recurring decimal, and that its period will contain as many digits as there are in the period of the multiplicand.

Example 1. Multiply $3{\cdot}2\dot{4}5\dot{6}$ by 7, ${\cdot}7\dot{1}\dot{4}$ by 4, and $1{\cdot}2\dot{3}\dot{6}$ by 11.

$$\text{(i)}\ \begin{array}{r} 3{\cdot}2\dot{4}5\dot{6} \\ 7 \\ \hline 22{\cdot}7192 \\ 3 \\ \hline 22{\cdot}7\dot{1}9\dot{5}\ \textit{Ans.} \end{array} \qquad \text{(ii)}\ \begin{array}{r} {\cdot}7\dot{1}\dot{4} \\ 4 \\ \hline 2{\cdot}8\dot{5}\dot{6}\ \textit{Ans.} \end{array} \qquad \text{(iii)}\ \begin{array}{r} 1{\cdot}2\dot{3}\dot{6} \\ 11 \\ \hline 13{\cdot}596 \\ 3 \\ \hline 13{\cdot}5\dot{9}\dot{9} = 13{\cdot}6\ \textit{Ans.} \end{array}$$

Here, we multiply in the usual way, and increase the last figure in the result by the figure (if any) carried from the first (to the left) column of the period of the multiplicand.

Example 2. Multiply $6{\cdot}2\dot{2}\dot{7}$ by $8{\cdot}26$.

$$(a)\ \begin{array}{r} 6{\cdot}2\dot{2}\dot{7} \\ 8{\cdot}26 \\ \hline 37362+1 \\ 12454 \\ 49816\ \ +2 \\ \hline \end{array} \qquad (b)\ \begin{array}{r} 6{\cdot}2\dot{2}\dot{7} \\ 8{\cdot}26 \\ \hline 373\dot{6}\dot{3} \\ 124\dot{5}\dot{4} \\ 498\dot{1}\dot{8} \\ \hline \end{array} \qquad (c)\ \begin{array}{r} 6{\cdot}2\dot{2}\dot{7} \\ 8{\cdot}26 \\ \hline 373\dot{6}\dot{3} \\ 1245\dot{4}\dot{5} \\ 49818\dot{1}\dot{8} \\ \hline 5143726 \\ 1 \\ \hline 51{\cdot}437\dot{2}\dot{7}\ \textit{Ans.} \end{array}$$

Here, first we multiply as in the case of whole numbers, and increase the last figure of each partial product by the figure (if any) carried from the first (to the left) column of the period of the

multiplicand. Thus we get (*b*) We now add these lines in the usual way, but to do this correctly we extend each line (except the top line) as far as the right-hand figure of the top line, by repeating the digits of its period. The number of decimal places as far as the end of the first period in the result must be $3+2$, *i.e.* 5. We therefore place the decimal point to the left of the 5th figure from the end; and the required product is $51{\cdot}437\dot{2}\dot{7}$.

Example 3. $1{\cdot}32\dot{5}\dot{6}\times 10 = 13{\cdot}2\dot{5}\dot{6}$.

Example 4. ${\cdot}3\dot{2}5\dot{6}\times 100 = {\cdot}32\dot{5}6\dot{2}\times 100 = 32{\cdot}\dot{5}6\dot{2}$.

Example 5. ${\cdot}\dot{5}\times 1000 = {\cdot}555\dot{5}\times 1000 = 555{\cdot}\dot{5}$.

C. To divide a recurring decimal by a whole number, we proceed as in ordinary division; but instead of bringing down a zero each time we bring down the digits of the period in rotation. If the divisor is a terminating decimal, we multiply it by that power of 10 which will make it a whole number, and also multiply the dividend by the same power of 10; and proceed as in the case of division by a whole number.

Example 1.

Divide $32{\cdot}6\dot{2}\dot{4}$ by 5.

```
5 ) 32·6242424...
     6·5248484...
```

The quotient is $6{\cdot}52\dot{4}\dot{8}$.

Example 2.

Divide $2{\cdot}7\dot{2}\dot{3}$ by 53.

Quot. = ·0513817...

```
53 ) 2·7232323...
     265
      73
      53
      202
      159
       433
       424
         92
         53
         393
         371
```

If we had to divide $2{\cdot}7\dot{2}\dot{3}$ by ·053, we should divide $2723{\cdot}\dot{2}\dot{3}$ by 53.

THE END.